Leading-Edge Motorsport Technology Since 1990

Racecar engineering™

September 2011 • Vol21 No9 • www.racecar-engineering.com • UK £5.50 • US $12.50

INSIDE THE RED BULL RB7

Adrian Newey reveals its secrets

Formula Student
Silverstone hosts world's finest young engineers

Blown diffusers
Have the FIA made the right decision for Formula 1?

Mosler GT600
Britain's offering to Japan's Super GT series

09

9 770961 109098

Our In-Line Filters Just Got Even Better.
New Components. More Versatility.
Modular In-Line Filters...Now Stackable!
Combine different filter elements into one stacked body for staged filtration that's unbeatable. Larger debris is filtered out in the first stage with a larger micron rated element. A finer micron element in the final stage finishes the job without congestion. A SMART DESIGN.
XRP xtreme racing products
FLOW
Sizes -6 through -20. Available with either AN end fittings or our HC Clamshell Quick Disconnect end fittings.
All filter bodies are 2.47" diameter.
New stacking adapters with differential pressure take-off ports attach to pressure gauges and measure pressure drop, letting you know when to change the element. Available with or without end cap.
Stacking adapters without differential pressure take-off ports available too.
NEW short filter body is 3" shorter than standard body. Uses the same mounting brackets and end cap configurations, either AN or HC. Also available without logo/graphics. A GREAT SPACE SAVER.
Pleated stainless steel elements in 45, 60, 75 or 100 micron screens. Optional 15 psi relief valve to override obstructions.
Still More Options
7100 SERIES CONFIGURATION Shown above with our HC quick-release clamshell ends and optional -10 female accessory port on the inlet side to accommodate temperature probes, specialty adapters, etc. GET CREATIVE.
7200 SERIES CONFIGURATION allows you to uncouple the filter body and drop in a new element in seconds.
Get the ConneXion.™
Space Saver Fuel Filters With Suction Strainers
#120 Mesh Screen Suction Strainer. Other micron elements available.
Threaded body with "AN" inlet to metric end outlet. 120 mesh suction strainer included. Sizes -4 thru -10. For alcohol or gas. Also available with clamshell body and "AN" ends or clamshell body and clamshell ends.
Threaded body with "AN" inlet and "AN" outlet. 120 mesh suction strainer included. Sizes -4 thru -10. Viton or EPR O-Rings included for alcohol or gas.
Space Saver Suction Strainer's metric outlet attaches directly to fuel pump with female metric threaded inlet ports. Excellent pump protection without restricting flow. Staged finer filtration on the pressure side of the pump is recommended to prevent cavitation, etc.
All space saver filter bodies are 1.115" diameter
Manufactured in the U.S.A. from quality domestic alloys.
Go to www.xrp.com for catalog downloads & new products
XRP®
THE XTREME IN RACECAR PLUMBING
UNITED STATES XRP, Inc. sales@xrp.com tel 562 861 4765 fax 562 861 5503
EUROPE James Lister & Sons motorsport@lister.co.uk tel 44 (0) 121 525 5800 fax 44 (0) 121 553 5951

With a 100 per cent record in qualifying and Sebastien Vettel leading the Formula 1 World Drivers' Championship heading into the summer break, the Red Bull RB7 stole the march on the rest of the F1 field in the first half of the year. Ferrari and McLaren bounced back with wins at the British, German and Hungarian Grands Prix but, as Red Bull's chief designer Adrian Newey turns his attention to the RB7's successor, the RB8, he talks us through the design of an extraordinary car.

In the meantime, Formula 1 has released its technical regulations that will come into effect in 2014. Plug-in hybrid systems, eight-speed gearboxes and small capacity turbocharged engines are all a good way forward, despite the 1.6-litre V6 formula. There are still issues to be ironed out, but the direction for Formula 1 is now clearly laid out.

With the global spotlight shining so brightly on Formula 1, introducing technical innovation is extremely difficult as to get it wrong is expensive, not only in terms of race results, but also exposure. The blown diffuser saga, however, is an example of innovation gone wrong. As a performance enhancer it is brilliant, but by using more fuel and with no relevance to production cars, we come down on the side of banning the technology.

This month we also turn our own spotlight on Formula Student, which had another successful year. Teams made an incredible effort to take part. The Palestinian team, for example, had to bypass the Israeli officialdom to get the pieces of the car to Palestine, then transport the completed car from the Gaza Strip to Silverstone in the UK.

The key feature for this year's leading Formula Student cars was weight reduction, a feature that is close to the heart of the leading designers in the sport. Competition was fierce, and we bring you full reports from around the world. Unfortunately, the German competition took place after *Racecar Engineering* went to press, but full details will be our website.

EDITOR
Andrew Cotton

10 COVER STORY
How Red Bull Racing's RB7 is dominating Formula 1

42 MOSLER
From GT3 to GT300. How a British firm went racing in Japan

58 FORMULA STUDENT
The Germans win again, but GFR sets the pace at Silverstone

The International Journal of Motorsport Technology
Racecar engineering

NEWS

COVER STORY

FIRST PRINCIPLES

ENGINEERING SOLUTIONS

INDUSTRY AND PEOPLE

FORMULA 1

Changes afoot for 2014

Formula 1 will undergo some fundamental changes in 2014 as the category bids to make itself more relevant to production cars.

The FIA released its Technical Regulations shortly before the German Grand Prix at the end of July. Externally, the cars will undergo some minor aerodynamic changes, such as a reduction in front wing width to 1650mm (from 2000mm) and the removal of the growing collection of brake duct winglets.

It's under the engine covers, though, that the major changes will take place. A large number of material specification changes will remain largely invisible, but a whole new powertrain formula will be employed.

The new engines will all be 1.6-litre turbocharged V6s and, with highly restrictive regulations, their design will necessarily be similar. The bore, for example, is to be restricted to 80mm +/-0.1mm, whereas under the current 2.4-litre V8 regulations teams are allowed any bore size up to 98mm. On the upside, bore spacing will no longer be restricted.

Only a single turbocharger will be permitted for pressure charging, but electronic turbo compounding is allowed.

However, the layout seen on the mono turbo Audi R18 is outlawed as the regulations specify that the exhaust gasses may only exit the engine outboard of the cylinder heads and specifically not through the central v. Variable geometry turbochargers will not be permitted.

All of the engines will be direct injection, but here too there will be restrictions. Only FIA-approved injectors and fuel pumps can be used, though it is not clear if teams will have to have the components approved ahead of use in the same way NASCAR teams do, or whether they will use a single, spec design.

As is the case this season, the engine's crankshaft position and c of g height is tightly fixed.

> "This forces all teams to employ energy recovery and hybrid (KERS) systems"

The weight limit will be increased by 20kg to 660kg, largely to accommodate the extra energy recovery systems fitted to all cars. Instead of a 60kW KERS system, which can only be deployed for around seven seconds a lap, a much larger 120kW system will be introduced.

Use of the V6 engine in the pit lane will be outlawed, meaning all cars will have to rely solely on electric power during pit stops and other runs along pit road. The energy storage medium itself is left up to the teams, but other regulations essentially limit the systems to batteries or capacitors. Critical amongst these is a rule that states that the energy storage unit should weigh between 20kg and 25kg. The storage must also be housed in the car's monocoque, outlawing layouts such as the one found on this year's Red Bull RB7. Teams will still be restricted to a single electric motor generator unit.

Unsurprisingly, F1 bosses have said there needs to be further discussion before they will be completely happy with the new ideas. Ferrari team principal, Stefano Domenicali, said: 'There are some manufacturers that are keen to go ahead with this project. Some others fear that,

not from a technical point of view, just from a show point of view, it is something that we need to make sure that the sport is happy for. This is a topic that, in my view, because it is for 2014, can still be discussed. We have the time to discuss it in a proper way.'

Domenicali added: 'There are different opinions on this subject because on one side there is the technical aspect and on the other side there is the sport and the passion. You may say that in the pit lane, with no noise, it would be difficult for people to perceive the passion that Formula 1 is all about. On the other side, you may say that Formula 1 has to be the pinnacle of motorsport in terms of new developments and research, so this goes in the opposite direction. I think this is something that we will discuss.'

James Allison, Renault technical director and head of FOTA's Technical Regulations Working Group, says that technically a single electric motor system should not be a problem. 'There are technical hurdles to be cleared in order to make it happen, but just things that make the configuration of the car change relative to what we've got today. It is a complication from a design point of view, but it's not an impossibility.'

The total power unit (engine, energy recovery systems and ancillaries) must weigh no more than 155kg and have a c of g height not less than 200mm above the reference plane.

It is likely that the first of these new power units will run on the test bench next year. Five engine manufacturers are known to be evaluating programmes, including Renault, Ferrari, Mercedes and Cosworth, who all supply teams with 2.4-litre V8 engines currently. The identity of the fifth manufactuer is not known, and the Volkswagen Group is believed to be taking a keen interest.

These 'power units', as the FIA dub the combined engine and energy recover systems, will drive the rear wheels through an eight-speed gearbox, something the drivers will no doubt struggle with around Monaco. Despite the inclusion of an extra gear (likely only to be used with DRS employed), the transmissions will probably lose their reverse gears. Whilst all cars will still be required to be able to travel backwards, the current requirement for a specific gear will be made redundant by the ability of the cars to run on the electric motor only. The bigger motors and energy storage will also negate the need for starter motors, despite a new regulation that states all drivers must be able to start their cars via a cockpit button alone (no external starter).

This forces all teams to employ energy recovery and hybrid (KERS) systems, something that is known to be a major challenge to both the engineering and financial departments. Currently, three teams do not employ KERS at all and others, such as Red Bull, struggle to make the technology work reliably.

CAUGHT

NASCAR Sprint Cup outfit, Joe Gibbs Racing, was caught with non-approved oil pans at Michigan during initial inspection at the track. The oil pans were weighted, but apparently the changes to the design were focused on adding front downforce and aiding aerodynamics. Any changes to approved items have to be assessed by NASCAR and this change fell under that heading, netting the three crew chiefs - Mike Ford, Dave Rogers and Greg Zipadelli - a hefty $50,000 fine each. Additionally, all three car chiefs and vp of racing operations, Jimmy Makar, were placed on probation until the end of the year.
FINE: $150,000 (£91,400)

Joe Gibbs Racing was hit with another large fine at Pocono when the no 18 Sprint Cup car was found to be outside the minimum height at the front. As a result, crew chief, Dave Rogers, was fined, while owner, Joe Gibbs, and driver, Kyle Busch, were both penalised with the loss of six championship points in the owner and driver championships respectively.
FINE: $25,000 (£15,200)
PENALTY: six points

Corrie Stott, crew chief at Stott Classic Racing - a part-time team in the NASCAR Nationwide Series - was fined and placed on probation until mid-August after an improperly attached weight was discovered during practice at Kentucky Motor Speedway.
FINE: $10,000 (£6000)

The crew chief at Robertson Racing in the NASCAR Nationwide Series was fined and placed on probation until August 17 after it was found that the car he was tending sported an unapproved inlet manifold at opening day scrutineering at Kentucky Motor Speedway.
FINE: $5000 (£3000)

BRIEFLY

Manufacturers return to Le Mans

Porsche has confirmed it will return to Le Mans in the LMP1 category in 2014, and rumours continue to circulate that Jaguar is also evaluating a return under its Indian owner, Tata.

Porsche's return is not thought to impact on Audi's programme, with Audi committing to diesel and Porsche likely to develop a petrol hybrid system. Drivers mentioned in connection with the Porsche programme include Nick Heidfeld and Nico Hulkenberg, while Romain Dumas and Timo Bernhard remain under contract to Porsche.

Daytona debut

The new generation of Grand-Am Daytona Prototype is on course to make its debut at next year's 50th anniversary running of the Daytona 24 Hours. The car, which is built to a new set of regulations, is to be called the DPG3 - as it's the third generation chassis - and we're told it will feature an all-new body with a smaller greenhouse that should help give the car more aesthetically pleasing proportions.

Grand-Am has received CAD models from each of the active constructors in the formula: Coyote, Dallara and Riley.

Number crunch

The increased overtaking in Formula 1 this year is only partly down to the Drag Reduction System. That's the finding of a detailed analysis carried out by Mercedes GP of passing moves during the season, which states that up until July's German Grand Prix there had been 623 overtakes - not including first lap passes or passes made because the car in front was damaged. The analysis shows 180 DRS-assisted passes and 225 'normal' passes (the rest were 175 by faster cars on cars from the bottom three teams and 43 between team mates).

• MORE NEWS ONLINE AT WWW. RACECAR-ENGINEERING.COM

DTM

DTM's new look on show

BMW and Audi are the first manufacturers to break cover with their 2012 DTM challengers, BMW unveiling its two-door M3 and Audi switching from its supremely successful A4 to the A5 coupé.

The M3 has already tested ahead of its unveiling at the Munich round of the series mid-July, and an intense test programme is scheduled as the manufacturer seeks to make a successful return to the DTM for the first time in nearly 20 years.

The M3 is still in the early stages of development and BMW Motorsport director, Jens Marquardt, commented, 'Getting a new racing programme up and running is a bit like doing a jigsaw. New pieces are added almost every day, and we must put them together to create the big picture.'

DTM stalwart, Audi, has announced that it is to switch its focus from its four-door A4 model to the two-door A5 coupé, codenamed the R17. Head of Audi Motorsport, Dr Wolfgang Ullrich, said, 'We've got exactly the right model in the A5. We're convinced that we'll be able to continue Audi's success story in the DTM with it.'

The new technical specifications for the DTM have been worked out by the German Motorsport Association (DMSB) and the DTM umbrella organisation, ITR. Audi says much of the focus has been on improving safety. 'Our engineers have been involved in bringing up safety in the DTM, which had already been high before, to the highest possible level,' said Ullrich. 'At Le Mans this year we learned again that our concept of designing safety structures is a very good and appropriate one.'

Striking features of the new, lower-cost formula include a move away from the intricate aero offerings of current DTM cars from Mercedes and Audi. There is no sign of the complex fan of wings aft of the rear wheels that adorn current cars, though there is a very large rear wing with distinctive, curved, 'swan neck', supports on both the BMW and Audi.

The new Audi R17 DTM concept shows how the 2012 challengers will look

LE MANS

LMS ditches LMP1

The Le Mans Series has announced sweeping changes to its format for 2012, with the exclusion of the LMP1 cars and the inclusion of an entry level GT class, alongside LMP2, LMPC, GTE Pro and GTE Am classes. Teams rejected proposals to shorten the races to 500km or four hours. A questionnaire was circulated to existing LMS teams at Imola at the start of July, asking which will compete in 2012, in which category and cars they would be competing, and offering a choice of tracks on which to race. No race dates have yet been announced, but organisers have hinted that they will race on top European circuits, and races will be separate from the European rounds of the WEC.

NASCAR

NASCAR fuel injection tested

NASCAR's new fuel injection system has been track tested for the first time, with five cars fitted with the McLaren-developed system taking to the oval at an open test at Kentucky Speedway.

Despite initial reluctance, fuel injection is to replace carburettors in the NASCAR Sprint Cup next year and five teams took the opportunity to run the system on a car each – Hendrick Motorsports, Richard Childress Racing, Roush Fenway Racing, Penske Racing and Michael Waltrip Racing.

The cars were tested alongside current Cup cars fitted with the familiar Holley carbs, with the injected cars proving marginally slower than their carburettor-fitted counterparts.

ECR engine builder, Danny Lawrence: 'Right now, we're working on fuel flow and driveability, making sure that when they mash the gas, it's a really smooth transition... we also want to make sure we don't hurt our engine.'

TRD's Dave Wilson agreed: 'Full-throttle load is the easiest thing in the world to tune to. It's all the part-throttle stuff – getting on pit lane smoothly, getting out of the garage smoothly – that is absolutely essential, and that we can't replicate in a dyno environment.'

NASCAR took the recorded data from the teams following the Kentucky test and its Sprint Cup Series director, John Danby, was impressed by the technical transparency an ECU offers. 'There's obviously the ability to log and record everything that happens during the process. We don't have to stand over their shoulder to watch anything. We can walk in tonight, hook up [and] walk off with what we need to look at.'

McLaren Electronic Systems and Freescale Semiconductor produce the ECUs, while Holley makes the throttle bodies. The ECU systems cost teams in the region of $26,000 (£15,875). The next scheduled session will be at the open test in October on the re-paved Phoenix track.

CAUGHT

Toro Rosso F1 driver, Sebastien Buemi, was excluded from qualifying for the German Grand Prix after an irregularity was discovered with the fuel in his car – but he was allowed to start the race from the back of the grid. The team said the issue was triggered by a fuel pressure problem. 'During Friday's FP1, Buemi's car had a fuel pressure problem, which then became worse at the start of FP2, which is why he did not do a timed lap in that session,' Toro Rosso explained. 'After FP2, the entire fuel system on his car was changed. When the fuel sample was taken from his car after qualifying, it did not match the one provided to the FIA prior to the start of the season. The team believes that some part of the new fuel system contained a chemical that contaminated the fuel and caused the non-conformity.

PENALTY: demoted to back of the grid

DATA CAPTURE

DL1 MK3 DATA LOGGER

Race Technology has recently released a fully revamped Mk3 version of its popular DL1 data logger. The key feature is its ability to perform calculations such as time slip 'live', which can be viewed by the driver in real time. In addition to this function, the unit can accept up to 14 analogue sensor inputs and four frequency inputs, with the logging rate increased to 2Khz to allow the effective use of damper pots.

As standard, the DL1 Mk3 comes equipped with a 2*g*, three-axis accelerometer, with a 6*g* unit available as an optional extra. There is also the option to upgrade the standard 5hz GPS unit to a 20hz item for more accurate track positioning.

The logger is supplied with Race Technology's in house-developed analysis software, which *Racecar Engineering* found exceptionally easy to operate, thanks to its intuitive interface.

For more information see www.race-technology.com

SET UP EQUIPMENT

CASTER / CAMBER GAUGE

Vehicle set up equipment specialist, Intercomp, recently released a new digital caster / camber gauge featuring a selectable caster swing range of 15 or 20 degrees. The gauge allows for accurate caster readings under 20 degrees swing, with accuracy of 1/10 of a degree, making it significantly more accurate than traditional gauges. The new compact design positively locates on the hub and features a built-in diagnostic mode for re-setting camber to zero, as well as a lit display for night time use. Additional magnetic and threaded adapters are available to enable fitting to different automotive and kart applications.

For more information see www.intercompracing.com

HARDWARE

FLANGED NUTS

Fastener specialist, ARP, has expanded its range of flanged nuts. The company can now supply over 43 different sizes, including 12 point and hex coarse threaded flanged nuts. Ten of the new introductions are made from heat-treated 8740 chromoly and rated to 180,000psi, with the others being made from ARP's high strength stainless steel.

For more information see www.arp-bolts.com

HARDWARE

NASCAR INJECTION LOOMS

Vehicle wiring harness expert, DC Electronics, can now supply complete looms suitable for fuel injected NASCAR Sprint Cup cars. All looms are built to military specification with contra wound lay up and repair loops. They are also computer tested to ensure 100 per cent functionality. In addition, experienced engineers are available for trackside support from the USA and UK.

DC Electronics is renowned for its rapid prototyping capabilities and can also design and supply test car data acquisition systems to suit individual team requirements.

For more information see www.nascarwiring.com

WORKSHOP PRODUCTS

GASKET ELIMINATOR

US-based SPA Turbo has come up with a new product, Gasket Eliminator, a sealant designed specifically for the turbo market. This grey, anaerobic paste seals metal-on-metal gaps up to 1mm in size and will cure within four minutes under normal engine operating temperatures. The paste provides resistance to low pressures immediately on assembly of flanges, then after curing is able to withstand high temperatures, high pressure, vibration and moisture. It also provides easy disassembly and clean up. SPA Gasket Eliminator adheres to steel, aluminium, brass and other alloys and is particularly suited for head to manifold interfaces and manifold to turbo system components.

For more information see www.nimbusmotorsport.com

Cloak of invincibility

As Adrian Newey begins work on the RB8, he guides us through the design process of this year's dominant design in Formula 1, the RB7

BY SAM COLLINS

With eleven pole positions, six wins and 383 points from eleven races it is fair to say that one car dominated the first half of the 2011 Formula 1 season. What's more, the Red Bull RB7 is unique. Whilst every other car on the grid started out with a click of a CAD screen, the RB7 started its life as a hand-drawn design on a piece of paper in Adrian Newey's office in Milton Keynes, England.

'Whether you use a CAD system or a drawing board, ultimately it's a way of taking thoughts from in your head, putting them into a medium, developing them in that medium and then communicating it with others,' explains Newey, the chief technical officer at Red Bull Racing. 'It's almost like a language, and what system you use is personal preference. But it is fair to say we couldn't realistically cope with many people in the company using drawing boards!'

> "A Formula 1 car is a phenomenally messy vehicle. An open-wheeled car is not something you'd design just by giving it a free hand"
>
> Adrian Newey

TECH SPEC

Class: Formula 1 (2011)

Weight: 640kg (inc 50kg ballast)

Monocoque: carbon fibre composite with honeycomb core; engine carried as a fully stressed member

Engine: Renault RS27 naturally aspirated 2.4-litre, 90-degree V8, rev limited to 18,000rpm, 32 valves, cast aluminium block; Total lubricants

Hybrid system: modified Magneti Marelli battery electric KERS – 60kW maximum output, 300kJ maximum storage – lithium chemistry batteries

Electrics: TAG 310B (Formula 1 spec ECU)

Transmission: rear-wheel drive; seven-speed sequential Red Bull Racing gearbox, longitudinally mounted with hydraulic system for power shift and clutch actuation

Clutch: AP Racing

Suspension: independent with carbon fibre double wishbones all round; pushrod with torsion bars at front, pullrod at rear; Multimatic adjustable dampers

Uprights: aluminium alloy

Brakes: Brembo carbon / carbon discs all round

Wheels: OZ Racing front 12 x 13; rear 13.7 x 13

Tyres: Pirelli F1 specification control slicks / wets

Fuel: Total

Fuel cell: ATL

Width: 2000mm

The RB7 is a clear evolution of the 2010 World Championship-winning RB6 and exhibits similar aerodynamic traits, as well as the pull rod-actuated rear dampers. The one major difference is the pacakagng of the KERS components, which have been moved rearward to improve the car's balance

Due to a regulation introduced for 2011 only, weight distribution was something less of a headache for Newey and his team. The weight distribution of all 2011 cars is fixed at no less than 291kg on the front axle and 342kg on the rear, and with the 640kg minimum weight, teams only had a 7kg window to work with. Other design limitations, such as the c of g height for the engine, also reduced some of the design choices.

The result was a clear evolution of the 2010 World Championship-winning RB6, with many of that car's concepts carried over, including the high, flat nose and compact rear end, as well as the Renault RS27 2.4-litre V8 engine. 'The RB5 of 2009 was the first of a new line of cars which come up with the best solution we could find to the big aerodynamic regulation changes,' says Newey. 'That was really the biggest regulation change since flat bottoms came in in 1983. We are always trying to maximise the downforce, have a reasonably broad operating window, get the weight distribution where you want it, have something that is structurally sound, and with a light c of g. It's all the obvious points, there's no magic bullet.'

> **"The aerodynamic regulation changes are the biggest since flat bottoms came in in 1983"**

The rear of the car features pull rod-actuated dampers, which Red Bull re-introduced to Formula 1 on the RB5. The resultant compact and 'great' rear end is the reason why driver Sebastien Vettel has dubbed his RB7 (chassis 03) 'Kinky Kylie'. Newey, however, takes something of a more reasoned view for the layout: 'the pull-rod suspension at the rear helped to package some of the major components lower down, so the design was really a combination of c of g height and general packaging, which we felt suited the new regulations much better than the push rod. It basically allows much tidier flow to the lower beam wing.'

This was the concept Red Bull attempted to exploit on the RB5, but it ended up being something of a hindrance once the double diffusers emerged. 'I think with a single diffuser car, pull-rod suspension is a very elegant solution,' Newey continues, 'but for a double diffuser, with the height the diffuser then uses, it's much less clear cut. It compromised RB5 a little bit by having to try and package a double diffuser onto a car that just wasn't designed for it. RB6, of course, was designed for the double diffuser, and then we debated whether to stay with the pull rod or not. I think we elected to because by then we had some experience with it, and were happy with how it worked in general. But equally, had we spotted double diffusers earlier, we may have stayed with push rod for RB5 and RB6. RB7 was always definitely going to be a pull rod because it's a single diffuser car, by regulation.'

It will likely be said in years to come that the FIA didn't quite get the under-body aerodynamic regulations right, as double diffusers gave way to the even more controversial hot blown floors. Most radically, this idea was exploited by Renault with the front exhaust exits seen on the R31. But while Red Bull has tried to optimise the exhaust exits on the RB7, it has not gone as far as a full hot blown diffuser.

'I think some people were saying that they hot blow the floors to balance their KERS out, which seems rather against the whole principle of it,' says Newey. 'It is meant to be a fuel saving

Red Bull use Brembo brakes on the RB7. The RB5 suffered with brake wear issues in 2009 but Newey says the technology has moved on since then: 'I think what you've seen along the grid is much more sophisticated disc drilling patterns than in 2009. In our own case, we supply our own spec to Brembo, but equally, Brembo has developed its own baseline spec in the intervening years, so their baseline spec is also to a high standard'

strategy, so to claim that you burn excess fuel and blow the floor in order to offset the influence of the KERS and achieve a neutral brake balance seems rather against the whole intent of green technology. The way we've been using the exhaust, the effect would be very small.'

GEARBOX EVOLUTION

For the first time ever, Red Bull is supplying technology to an outside team (Toro Rosso is owned by Red Bull), its pull-rod transmission being found on the Team Lotus T128. That gearbox is essentially the one used on the single diffuser RB5 and STR04, and the RB7 also leans heavily on the same design. 'The internals are almost identical to the RB6, but its casing is different, primarily because we are returning to a single diffuser. This raised the question, why is the RB7 gearbox different to the RB5? The answer is just general evolution and packaging and, of course, the fact that we've chosen to put the KERS alongside the main case.'

If the RB7 does have an Achilles' heel, it must be its energy recovery, and team radio transmissions during the early race races with the system publicly demonstrated the issues the team was experiencing.

'At the root of the problem is the fact that we have tried to develop the KERS package ourselves,' explains Newey. 'It is based on the Magneti Marelli system that Renault used in 2009 and which we briefly tested on the RB5 pre-season before electing not to race it. Since then, everybody has gone off in different directions with that system as a basis, including ourselves. Developing KERS just isn't our strength. We are mechanical engineers, aerodynamicists and vehicle dynamicists, not KERS specialists.

'Part of the problem is that we have chosen quite aggressive packaging, putting the batteries alongside the bellhousing at the back of the car, which we've felt was good for the overall package of the car. Everybody else now has the batteries at the base of the fuel tank. For a packaging point of view, we felt that ours was a better route. We knew there would be heat issues with our placement of the batteries as

DIGITAL BACKBONE

Adrian Newey's unusual, anachronistic even, approach of using a drawing board presents a unique challenge to Red Bull's design team. 'Once I've done my paper drawings, they then have to be scanned, and then there's a team of two or three people that have to take those drawings and turn them into solid surface models. Nowadays, a drawing itself is of no use to anybody. Whether you're evaluating it in CFD or in a wind tunnel, the manufacturing is in the electronic world. The wind tunnel model and the manufacturing use computer-controlled machinery. The team have got used to me now.'

While Newey still relies on paper and French curves, the rest of his engineers use advanced digital tools to develop concepts. The team has a partnership with Siemens, and uses its NX software. It also utilises Teamcenter PLM to ensuring accuracy and consistency of models and bills of material. 'I think it's the system that the guys here all felt comfortable using,' adds Newey. 'We benchmarked various different systems in terms of overall performance and flexibility and how we wanted to use it, and found that it was the one most suited to us.'

ENSURING PERFECTION

'We have no time for mistakes,' says Chris Charnley, quality manager at Red Bull Technology (the design and manufacturing arm of Red Bull Racing), 'basically in our business we are continuously developing prototypes.'

Red Bull engineers employ a range of Leica Geosystems' laser trackers in the Milton Keynes factory to ensure all prototypes are as accurate as possible. The designers frequently contact quality engineer, Mike Hughes, when they wish to check the dimensional integrity of a new component. 'They come to us and ask not just if we can measure the part, they ask us for a 'Leica check'. The measurements from laser trackers are reliable and authoritative, and word has got around.'

Red Bull Technology measures the assembled racecars, as well as the individual components, as ensuring the car is legal is a key role for the systems. As Sauber found to its cost at the opening race of 2011, mistakes here can have a major impact on points scored (both of the Swiss cars were disqualified when it turned out the rear wings had been incorrectly measured), and here the technical partnership with Hexagon Metrology really pays off. A few seasons ago, the team urgently required an accurate measuring machine. One 'phone call to Hexagon in Barcelona and a laser tracker was quickly sourced. The machinery park at Red Bull Technology now includes several product generations of Leica Geosystems' laser trackers, and similar systems are in use at the Red Bull Racing wind tunnel.

'The Leica Absolute Tracker is a brilliant all-purpose tool and without doubt one of our best investments,' says Charnley. 'The speed of measurements justifies the investment by the time saved on component measurement. We are always discovering more uses for it. Accuracy, portability and reliability inspire the team.'

Metrology tools are an integral part of the design and manufacturing process at Red Bull, both to ensure the dimensional integrity of prototype components and also to ensure the finished car meets the strict regulations

The RB7 has its KERS hardware mounted alongside the gearbox housing at the rear of the car, something that plays a significant factor in the car's weight distribution. Such layouts are banned under the new-for-2014 rules

it is a fairly hostile environment, and heat management has been a little bit of a problem. But most of the other problems have been, I think more than anything, simply our lack of experience in that area.'

This is one of the key areas in the design of the RB7. Placing the lithium chemistry cells at the rear means the car has some significant differences to its rivals. Notably, the RB7 uses a small volume fuel cell as the batteries are not located there, which is a major difference to the RB5, which was designed to take KERS. 'On that car it was in the fuel tank, so the RB7 is kind of in between RB5 and RB6. When we freed up the volume for fuel between RB5 and RB6, we also changed the shape of the monocoque alongside the fuel cell at the same time. Inevitably, there's always a fight between radiator packaging and fuel volume as they are fighting for the same volume.'

NEW TYRES PLEASE

The re-introduction of KERS joined DRS as headline changes for the 2011 season, but one of the critical issues for the teams was the arrival of Pirelli as the sole tyre supplier to Formula 1. With the RB7 proving to be the fastest car in qualifying and winning the most races, it could be said that Red Bull got the best out of them, but Newey is not so sure. 'Ferrari seem to be pretty kind on their tyres, arguably kinder than us,' he says. 'It's not as simple as having a good tyre model, then you understand the tyre. That might allow you to understand it, but it won't necessarily mean you can get good performance. In truth, I think our pace is more the overall car. I like to think that if we were on Bridgestones, our performance relative to the others would be probably fairly similar to where we are on Pirellis. In other words, I don't think that the change from Bridgestone to Pirelli has particularly caused a change in the competitive order.'

If it isn't the overall car concept that makes the RB7 so strong, what is it? Newey is well known for having an aerodynamic-led approach to

P.MU RACING WINS!

WTCC, BTCC, NASCAR, ALMS, V8SUPERCARS, PORSCHE, DUBAI24HRS, VLN SERIES

In just a short time, PMU Racing brake pads have chalked up an impressive list of victories in most major international categories. Every weekend, more race teams the world over are discovering the PMU Advantage. Whether your racing Sprint, Rally or endurance discover the PMU racing advantage today... before your competition does.

The P.MU RACING Advantage

- Unrivalled stopping power
- Outstanding fade resistance
- Industry leading modulation & 'release' characteristics
- Low rotor wear

Carbon Metallic (Sprint) & Sintered Metal (Endurance) compouds available

P.MU Racing, the worlds finest motorsport brake pads are now available through our global distribution network.

Contact your local distrubutor to experience the P.MU Advantage for yourself.

GLOBAL DISTRIBUTION CENTRE
Racer Industries +61 7 5591 8198 sales@pmuracing.com
286 Southport Nerang Road, Southport, Queensland AUSTRALIA

OFFICIAL DEALER P.MU Project μ

INTERNATIONAL DISTRIBUTORS LIST:

USA NASCAR/Sportscar	Pro Systems - Moorsville NC - www.prosystembrakes.com
USA West Coast	Mackin Industries - Santa Fe Springs CA - www.mackinindustries.com
United Kingdom	Questmead - Lancashire UK - www.questmead.co.uk
United Kingdom	Roll Centre Racing - Cambridge UK - www.rollcentre.co.uk
Germany	Leit Speed - München DE - www.leitspeed.de
Belgium	Mosa Frein - Namur BE - www.mosa-frein.be
Italy	Tecnauto - Milano IT - www.tecnautosrl.com
South Africa	VMP Motorsport CC - Maraisburg SA - vmp@iburst.co.za

www.pmuracing.com

P.MU RACING

FRONT AERODYNAMICS

The RB7 follows the RB6 in that it has a high and flat nose - something that has since been copied by other teams such as Sauber and Mercedes. According to Red Bull, it is all to do with the FIA-spec centre section of the front wing.

The endplates are designed to push air around the outside of the wheels, rather than between them. Newey explains why this is: 'With the RB5, right from the start, we tried to take that direction, which was part of understanding the regulations, and clearly the fact that the wing has gone from, I think it was 1400mm wide to 1800mm wide between, with the regulation change over the winter of 08/'09. So, we've taken that direction, other people didn't necessarily at the start of 2009, but they started to adopt that through the year.'

his cars, and the current family of Red Bulls is no different. 'It is the way I've always operated, pretty much from the start of my career. I graduated as an aeronautical engineer, which means not simply aerodynamics. Aerodynamics was one of the subjects that one takes on the course, but so are structures, controls and so on. It seemed quite apparent to me that aerodynamics, from the very early 1980s or late '70s, was becoming the major performance differentiator between the cars. So it makes sense for the aerodynamic side to lead the overall design of the car in terms of packaging. All the cars that I've been in charge of, dating back to the IndyCars of the mid-'80s, have been designed to that ethos.'

This does not mean that aerodynamics always take priority, of course. Newey takes a pragmatic view to handling the engineering trade offs. 'We have sufficient research and simulation tools that we should be able to answer questions. So for instance, if there's a compromise to be made between weight or stiffness, which are the usual things, then we should be able to input numbers and let the numbers speak for themselves.'

It all sounds easy when Newey says it, but his rival designers continue to struggle to match his cars, and now he is turning his attention to the RB8. Judging by past form, it is likely to be another product of a very strong family line.

ASSESSING THE RIVALS

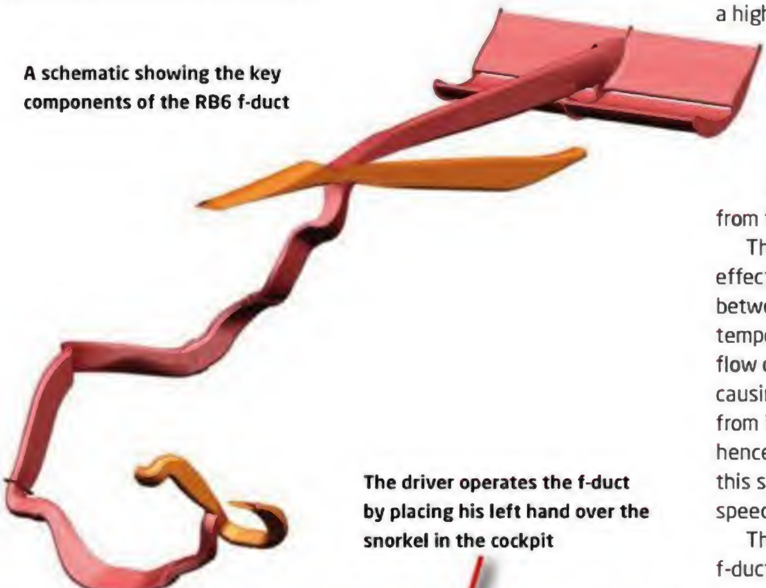
Adrian Newey is known for studying the cars of rival teams at grand prix weekends and, of all the current cars, he sees the Renault R31 as the most intriguing. 'The Renault is interesting because of what they've done with the exhaust,' he says. 'They've obviously chosen to put the exhaust where they've put it, but then they've chased that through quite thoroughly, in terms of what that then involves in terms of the side structures, the radiator and exhaust packaging and how you manage the heat. Putting the exhausts out in that position is a major engineering exercise. Whether it's the right thing to do aerodynamically is another matter. I certainly find that looking at other peoples' cars, occasionally you see something and think, 'why have they done that?' And that might be a source of inspiration.'

Replaced by DRS for 2011 one innovation was present on the Red Bull RB6, which is discussed in the new 'owner's manual' from Haynes Publishing. The following is an extract from it.

The f-duct was an innovation for 2010, first developed by McLaren. The system appeared on the RB6 for the first time at the Turkish Grand Prix in May. Adrian Newey explains the system's origins: 'Really it was experimentation. The f-duct technology actually stems from the Cold War in the 1950s, when the Americans were worried the Russians would develop ways of jamming the electronics on their fighter aircraft, and so they developed, effectively, a pneumatic version of electronics. So an f-duct is actually a transistor, but using air rather than electricity.'

Although a high level of rear downforce is desirable under certain circumstances (on slower, low-grip circuits and when cornering), on a high-speed straight ultimate speed is compromised by a high level of downforce, as a high downforce wing produces a high level of drag.

The idea behind the f-duct was to provide the car with a straight line speed boost by temporarily reducing the drag created by the rear wing. Two elements are used on the rear wing to prevent the wing from stalling, by creating a slot to allow high-pressure air to bleed through. So, if this effect can be reversed, and the wing can be deliberately stalled, drag (and downforce) will be reduced and straight-line speed increased. Of course, this is only desirable in a situation when downforce is not so important - such as on a long straight - so the effect needs to be temporary, or 'switchable'.



A schematic showing the key components of the RB6 f-duct

"the f-duct technology actually stems from the Cold War in the 1950s"

An attempt to achieve this effect was first made during the 2004 season, when several teams used 'flexible' rear wings, which allowed the slot between the two elements to close up under high load (for instance, on a high-speed straight), stalling the wing. From the 2006 Canadian Grand Prix, by regulation rigid separators had to be fitted between the wing elements to prevent them from flexing.

The f-duct achieved the same effect as closing up the slot between the wing elements, by temporarily allowing extra air to flow over one of the elements, causing the airflow to separate from it (flow separation) and hence stall it. It was found that this system could create a top speed increase of up to 4mph.

The key to optimising the f-duct system was to develop a rear wing design that stalled under the influence of the f-duct, but did not compromise downforce when the system was not in operation. The RB6's system took time to develop, and initially the air from the f-duct was blown over the wing upper element. A reasonable stall was achieved, but at the expense of a small reduction in rear wing performance when the system was not being operated. The system was developed and improved during the season and, at the Japanese Grand Prix, a major revision appeared, with the air from the f-duct being blown over the main wing element rather than the upper element.

The switching of the airflow from the lower to the upper duct in the engine cover is being achieved by using a 'fluid switch' operated by the driver. The basic method of operation is as follows:

- 'Control' air flows into the system ducting through an intake in the right-hand sidepod. In the 'default' position, this air flows out through the 'snorkel' on the left-hand side of the cockpit.
- 'Stall' air flows into the ducting from an intake in the bodywork above the driver's head, above the main engine air intake. In the default position, this air flows out through the outlet in the rear bodywork below the rear wing lower element.
- The driver places his hand over the snorkel to activate the system.
- The 'control' airflow is diverted along the ducting inside the engine cover, where it deflects the 'stall' airflow upwards so that it exits through the void in the rear wing upper element (early season) or over the main wing element (late season). The stall airflow creates turbulence at the rear of the wing element, stalling the airflow.

The driver operates the f-duct by placing his left hand over the snorkel in the cockpit

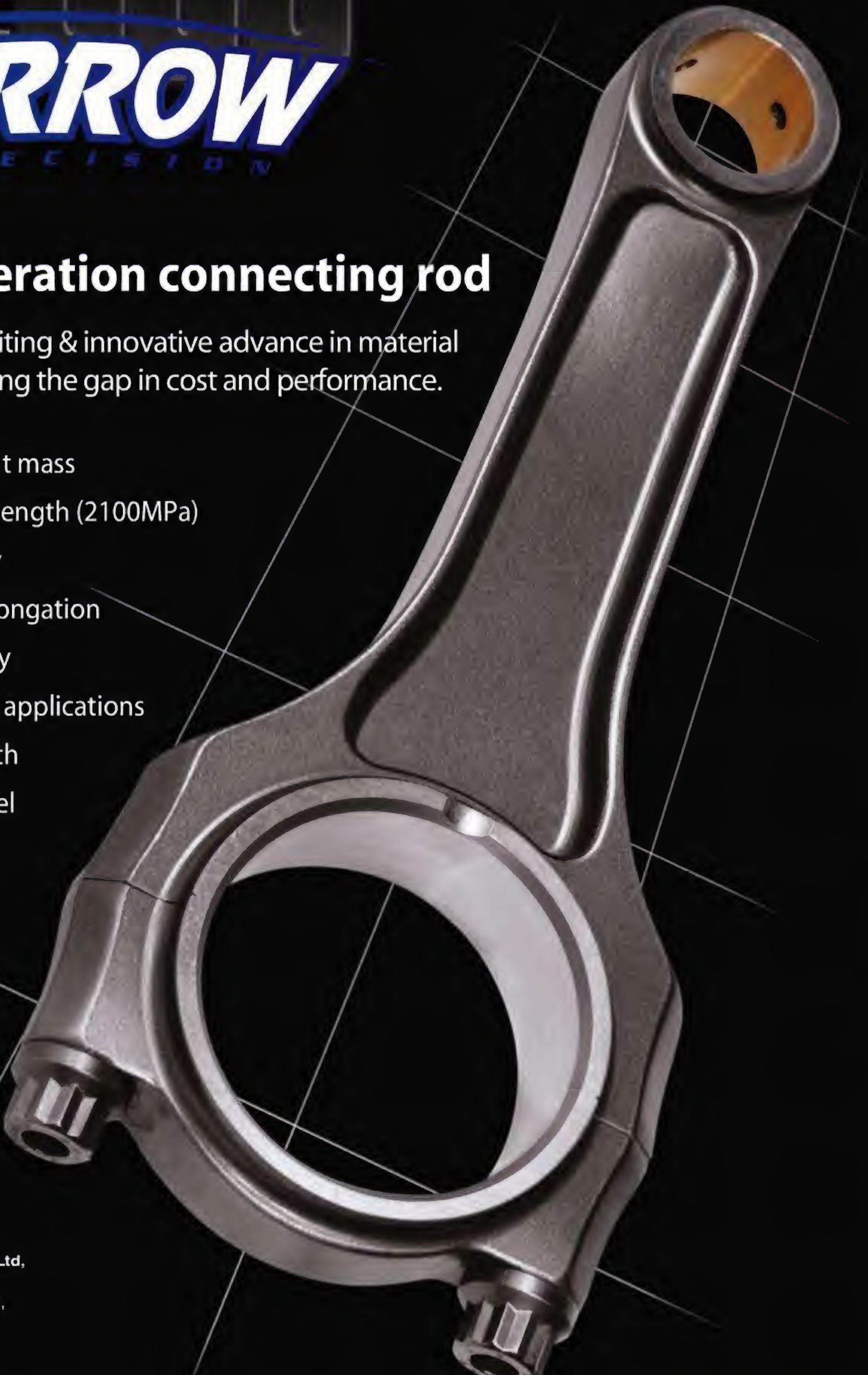
M2000

ARROW PRECISION

a new generation connecting rod

M2000 is a truly exciting & innovative advance in material specification, bridging the gap in cost and performance.

- reduced component mass
- exceptional core strength (2100MPa)
- increased durability
- maintains plastic elongation
- low notch sensitivity
- ideal for high stress applications
- high fatigue strength
- high tempering steel



Arrow Precision Engineering Ltd,
12 Barleyfield,
Hinckley Fields Industrial Estate,
Hinckley, Leicestershire.
LE10 1YE
United Kingdom

tel: +44 (0)1455 234200
fax: +44 (0)1455 233545
web: www.arrowprecision.com
email: enquiries@arrowprecision.com

Made in England

ARP authorised Agents for ARP

at the heart
of the world's
most powerful
engines.

FIRST PRINCIPLES

Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques – www.sm-aerotechniques.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

Produced in association with MIRA Ltd

Tel: +44 (0) 2476 355000
Email: enquiries@mira.co.uk
Website: www.mira.co.uk

Maximising downforce

Miscellaneous modifications to the ADR3 Sports Racer

This month we continue investigations on the ADR3 twin-seat Sports Racer. The aim of a busy session in MIRA's full-scale wind tunnel was to produce the best downforce possible, together with a front-to-rear downforce balance to match the car's static weight distribution with driver and half fuel aboard. The car started the session with very little front downforce, and in the previous two issues we saw how splitter and diffuser modifications at the front, opening up the sidepods and re-locating the rear wing enabled the desired balance to be achieved, while simultaneously increasing total downforce and efficiency and reducing drag. Lots of other modifications were also tried, some of which were beneficial, some of which were not, but all produced valuable knowledge for the team.

BALANCE TUNERS

The purpose of louvres in the top of wheelarches is to reduce lift. This is achieved by relieving pressure build up within the wheelarch, and probably also in the case of 'positive' louvres that protrude above the body surface, by killing some of the naturally occurring upper surface lift arising from the airflow accelerating over the wheelarch's convex shape, which of course is accompanied by a reduction in local static pressure. So blanking off wheelarch louvres at the front would be expected to reduce front downforce, right? This exercise provided a clearer overall picture.

The front louvres on the ADR extended from well forwards to well aft of the top of the arches, so they were blanked off in three successive increments. First, the rearmost three louvres were taped over on each side. Then the front three louvres only were taped over. Finally, the whole louvred panel was replaced with a smooth blanking panel on each side. The results are shown in table 1, as changes relative to the previous configuration. The changes are shown in counts, where a coefficient change of 0.100 = 100 counts, and in percentages, and the Greek letter delta (Δ) is used to indicate 'change to'.

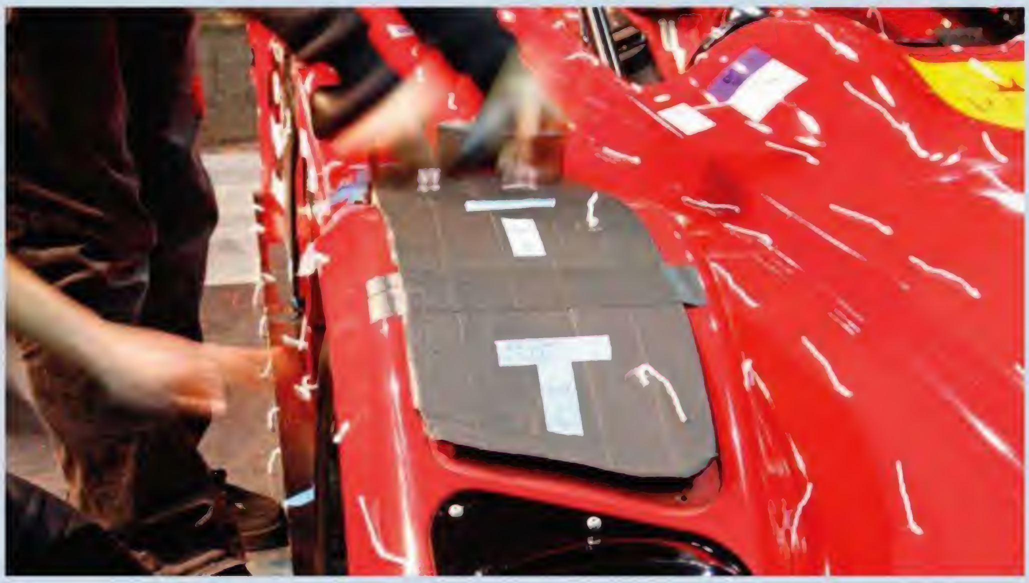
So the initial expectation that these louvres, when opened up, would create more effective front downforce is borne out here by the decrease in front downforce when they were sealed off. And the effect on front downforce when all of the louvres were sealed was really quite significant. This, remember, is with non-rotating wheels too, and we might expect an even greater, speed-related effect with the wheels spinning within the arches, pumping air around.

It's interesting too to note that minor but similar balance changes were brought about by taping over either the front or rear three louvres on each side, but the manner in which these changes occurred was actually rather different. In all cases though, front downforce decreased and rear downforce

Table 1: the effects of progressively blanking off the front wheelarch louvres, in counts and per cent

Blank off	Δ CD	Δ -CL	Δ -CLfront	Δ -CLrear	Δ %front	Δ -L/D
Rear three louvres	+4 (+0.7%)	+13 (+1.3%)	-6 (-1.6%)	+20 (+3.1%)	-1.03abs* (+3.1%)	+10 (+0.6%)
+Front three louvres	-4 (-0.8%)	+5 (+0.5%)	-8 (-1.7%)	+13 (+2.6%)	-1.08abs* (-2.2%)	+25 (+1.3%)
All louvres	-5 (-1.0%)	-14 (-1.4%)	-66 (-14.4%)	+52 (+10.2%)	-6.23abs* (-13.1%)	-9 (-0.5%)

** abs = absolute change in per cent front (relative percentage change in brackets)*



Blanking off all of the louvres on both front wheelarches had a significant effect on the downforce generated

Airflow passing over (and emerging from) the front louvres encounters the outer region of the rear wing further downstream

The engine bay inlet snorkel was replaced, and produced interesting results

The wool tufts in the centre of the wing's trailing edge show how the engine inlet snorkel affected the airflow downstream

It was hoped that opening the rear of the rear wheelarches and adding ramps at the back would collectively reduce drag and add rear downforce

Table 2: the effects of removing the snorkel intake, in counts and per cent

	Δ CD	Δ -CL	Δ -CLfront	Δ -CLrear	Δ %front	Δ -L/D
Remove snorkel	-9 (-1.5%)	+47 (+4.6%)	+19 (+5.6%)	+28 (+4.2%)	+0.31abs (+0.9%)	+106 (+6.2%)

Table 3: the effects of modifications to the rear wheelarches, as changes

	Δ CD	Δ -CL	Δ -CLfront	Δ -CLrear	Δ %front	Δ -L/D
Rear arch modifications	-4 (-0.7%)	+6 (+0.6%)	+2 (+0.6%)	+4 (+0.6%)	+0.01abs (+0.03%)	+23 (+1.3%)

increased. The rear downforce increases, which in the first two cases were greater than the front downforce reductions. This may have been the result of improved flow to the outer portions of the rear wing, the converse being true were the louvres to be opened up. Certainly the airflow passing over (and emerging from) the front louvres encounters the outer region of the rear wing further downstream.

Blanking the front three louvres increased the efficiency more than taping over the rear three louvres by reducing drag slightly, the opposite again being the case if those louvres were to be opened up. But blanking off the rear three louvres also increased rear downforce slightly more, while making a similar difference at the front of the car as blanking off the front three louvres. So small changes to the numbers of louvres opened or closed could be used as balance adjustment tools, providing sufficient front-end downforce was available in the first place. In this case, the car really needed all the front louvres open to maximise front-end downforce.

REMOVING THE SNORKEL

As mentioned briefly last month, the ADR's intake snorkel on the rear body section fed into the engine bay rather than being directed into an airbox sealed to the engine. It was felt that this would be causing drag and possibly rear lift as well. The results of replacing the snorkel with a flat engine cover with no feed into the engine bay are show in table 2. The results are again given as changes relative to the previous configuration. As hoped, this change did reduce the drag by a modest amount, and added more rear downforce. But it also added front downforce too, to the extent that there was barely any balance change. Efficiency was obviously well up as well.

So how could such a change yield more front, as well as more rear downforce? Well, there would seem to be two possibilities. First; rear wing performance, which could be seen to be impaired in the centre by the snorkel, as evidenced by the wool tufts on the wing's trailing edge, probably improved and this may in turn have increased the interaction with the diffuser and benefited the whole underbody's downforce contribution, too. The other possibility might be that removing the snorkel allowed faster flow over the rear deck and into the wake, and this improved extraction from the diffuser to the betterment of the whole underbody, too.

REAR ARCH RAMPS

Finally, the effect of truncating and opening up the rear of the rear wheelarches and simultaneously adding ramps to the rear of the wheelarches was examined. These modifications, it was hoped, would reduce drag and add some rear downforce, and what happened is shown in table 3.

So, at this stage in the car's development, this was too small a benefit to justify parts manufacture, but at least the result was positive. Next month we'll see what happened to the ADR3's aerodynamics when we introduce small yaw angles.

Racecar Engineering's thanks to ADR Engineering, Carbon Weezel and Simon Marsh.


VAC MOTORSPORTS
VAC ENGINEERED SOLUTIONS
Complete Engine Builds - Street, Race
Cylinder Heads - Stages 1, 2, 3
Oil Systems - Coolers, Pumps
Dry Sump Kits
Racing Crank Dampers
Underdrive Pulley Sets
Vanos Elimination Kits
Race Seat Installation Kits
Complete engine machine shop with five CNC machines and in-house Engineering staff.
Cars across the world have been running VAC Solutions since 1984.
ONLINE STORE WITH OVER 3,000 PRODUCTS
PISTONS
ARP automotive Racing products
SCHRICK MEMBER OF THE AVL GROUP
COMETIC GASKET
MoTeC
KMS Kronenburg Management System
WWW.VACMOTORSPORTS.COM
TEL: 215.462.4666
PHILA, PA USA


The original CONNECTORS
METICULOUSLY ENGINEERED TO CONNECT
ADEL WIGGINS Flexible Tube Connectors
THE POWER TO SECURE
Stay connected with Adel Wiggins Flexible Tube Connectors! The difference between winning and losing is in the connection. Do not sacrifice a win to a simple hose blowout or burst. This occurs when conventional hose clamps or barbs fail to secure the hose located between the connections or components. Adel Wiggins Flexible Tube Connectors eliminate these failures. This is why so many professional racers today confide in them.
THE POWER OF EFFICIENCY
Adel Wiggins Flexible Tube Connectors are very efficient when it comes down to valuable time sensitive installation or removal. They can be quickly removed and installed with only one hand, whether they are being used with tubing or hose. The locking latch design eliminates troublesome and time-consuming installation of safety-wire or the necessity of tools to make the connection. The electrical bonding feature eliminates the external clamps, fasteners and jumper wire required in some applications. The W900 series minimizes weight and unit cost, while retaining the proven performance and reliability of other WIG-O-FLEX connectors.
GET CONNECTED!
Adel Wiggins Flexible Tube Connectors are offered standard in lightweight aluminum and are available in stainless steel or titanium upon special order. They feature an operating temperature range from -120° F to 800° F and are able to withstand boost and pressure levels in excess of 125 PSI.
CONNECTOR APPLICATIONS:
• Full Engine • Radiator • Intercooler • Oil Cooler • Turbo & Blower • Throttle Body
GET CONNECTED!
FULL ENGINE APPLICATIONS
FCP
Fluid Control Products, Inc.
Australia: Rocket Industries 02 8825 1900 | England: Goodridge UK 01392 369090 • BMRS 0175 355 3610 • Earls UK 0132 785 8221
Germany: Goodridge Deutschland 06321 60168 • Krontec 09401 52530 | Italy: Tecnauto SRL 02 738 8773
Japan: SiFo Corporation 03 5420 4154 | New Zealand: Turbo Vehicles Ltd. 09 525 6696
Toll Free in NA: 800-541-2345
Worldwide: 217-324-3737
www.fluidcontrol.net

FIRST PRINCIPLES

Mark Ortiz Automotive is a chassis consulting service primarily serving oval track and road racers. Here Mark answers your chassis set-up and handling queries. If you have a question to put to him

Email: markortizauto@windstream.net
Tel: +1 704-933-8876
Write: Mark Ortiz
155 Wankel Drive, Kannapolis
NC 28083-8200, USA

It's all about maximising the yaw moment, you see

Toe out for turn in

THIS MONTH:

Q1 **Is popular opinion that toe out makes for faster turn in actually true?**

A1 Yes, with toe out, in a corner both tyres produce lateral and drag force, creating a yaw moment and greater yaw acceleration

Q **Popular wisdom suggests that for a faster turn in, toe out is the way to go. However, I've never read a satisfactory explanation why, and it seems counter-intuitive to me. Thinking about what happens at the tyres, if you have toe out on turn in the outside tyre has to pass 'over centre' before it begins building grip in the direction of the turn. Thinking that the outside tyre is carrying most of the load, and therefore creating the majority of the grip, I would think that toe in would provide a faster turn in as you would be building grip faster as the more loaded tyre would already have a slight slip angle before you even turn the wheel.**

I have a theory that maybe the cause of this prevalent opinion could be the change in relative wheel heights as the scrub radius / caster kingpin / trail cause the inside front wheel to move down in relation to the chassis and the outside to move up.

It would seem that with a fast enough turn in that the inside was temporarily the heavier loaded tyre, its steered angle would create more grip than the outside until the point that the load transfers to the outside tyre.

If this is the case, it would seem that in softly sprung vehicles with lots of steering inclination, toe out would be the way to go, at least on tight courses requiring fast turn in. Your thoughts?

A Cars do generally exhibit quicker initial turn in with static toe out. My analysis is that this does not have to do with the lateral (y axis, per SAE convention) forces from the front tyres, but rather the longitudinal (x axis) forces, which can also produce yaw moments.

When the car is running straight, and the front tyres have either toe in or toe out, the tyres are both running at a slight slip angle, and accordingly generating both some lateral forces and some drag forces. The drag forces are roughly equal, and additive. The lateral forces are roughly equal, and opposite in direction, so they approximately cancel.

When the steering wheel is turned just a tiny bit, one front wheel will be running straight, and the other will be turned into the corner, generating a bit of drag, and some lateral force into the corner.

If the car has toe in, it will be the inside front wheel that's running straight, and the outside one that has some slip angle. In this condition, the lateral force creates a yaw moment into the turn, but the drag force creates a yaw moment out of the turn. The two yaw moment components are subtractive.

If the car has toe out, it will be the outside front wheel that's running straight, and the inside one that's making lateral force and drag force. Now the lateral and drag force both create yaw moments into the corner, and are additive. Consequently, the net yaw moment is greater, and the car experiences a greater yaw acceleration. That is it turns in quicker.

Camber gain recommendation

THIS MONTH:

Q2 **What camber gain should I design into my uprights?**

A2 My standard recommendation is 0.6-0.9 degrees per inch (0.02-0.03 degrees per mm) for camber recovery rates between approximately 50 and 25 per cent

Q I have built two 7s-type cars and am now busy with an exoskeletal car for out-and-out track racing. Do I go for the unequal double wishbone design (top wishbone two thirds of the bottom)? And what should be the camber gain that I design into my uprights? (I do not know how much the car is going to roll). On an independent rear suspension, does one strive to get the camber gain front and rear the same?

Unequal double wishbone is good. Top wishbone 2/3 of the length of the bottom is also a reasonable rule of thumb recommendation for uprights of typical dimensions. You don't need to worry too much about straying from the 2:3 ratio if packaging or structural requirements dictate.

'Camber gain' typically refers to the rate of camber change per unit of suspension displacement, as measured statically in the shop, moving the wheel or upright up and down with a jack and measuring camber change as the displacement changes.

My standard recommendation for camber gain is 0.6-0.9 degrees per inch, which would be roughly 0.02-0.03 degrees per millimetre. With typical track widths, this gives camber recovery rates between a bit less than 50 per cent and a bit better than 25 per cent. That is, ignoring roll due to tyre deflection, and ignoring other compliances, the wheels lean a bit more than half as much as the body in cornering, but less than three quarters as much, and they don't experience any huge camber changes due to acceleration, braking and bumps.

The basic rule of thumb that says the upper wishbone should be 2/3 of the length of the lower one still holds true

> Cars work fine with little geometric anti-roll

We also need to avoid excessive jacking. That is, we want the roll centres fairly low, with modest geometric anti-roll. There is no hard and fast relationship between camber gain and geometric anti-roll when we have total freedom to move all points but, in the majority of cases, where we face packaging constraints and have committed to some point locations, more camber gain will produce more lateral anti, or higher roll centres.

My general recommendation is that at static ride height, the force line - the line from the contact patch centre to the front view instant centre – should slope upward toward the centre of the car, at around four degrees. In no case should the slope be more than eight degrees (when the roll centre is around 4in above ground). This means that the coordinates of the front view instant centre, using the contact patch centre as a local origin, as in Mitchell software, should have z (vertical) and y (transverse) coordinates with a ratio around .07 z/y, or in no case more than .14.

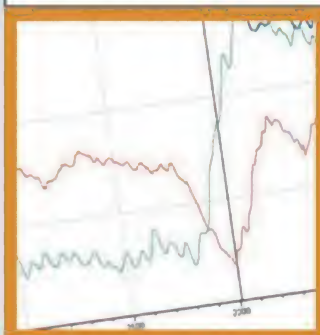
You will want to make sure you stay within these limits at the highest ride height you design for. Generally, racecars have their ride height tuned to the circuit. With a smoother surface, we can run the car lower, and we should. Generally, that lower ride height brings lower roll centres. That's okay.

It's not bad if the geometric anti-roll is very small, or even negative (roll centre low, or below ground), but don't let it get too high. When there is little geometric anti-roll (roll centre near the ground), the lateral location of the force line intersection will move all over the place with suspension movement. Some people will tell you that the force line intersection is the roll centre, and / or that you can model car behaviour by taking moments about that point, and that minimising lateral (or vertical) migration of that point is vital to good car behaviour. It isn't true. Don't worry about it. Cars work fine with little geometric anti-roll. Just don't have a lot with independent suspension as that does create problems.

TOTAL SEAL®
High Performance
PISTON RINGS
The Leader in Piston Ring Innovation & Technology...
Total Seal® Advanced Profiling™ Steel Rings
• Stronger and Longer Life – Most Precise Tolerances
• Thinner – Flatter – Lighter
• Conforms Better to the Cylinder Wall
• More Face & Anti-Friction Side Coatings
• Custom Sizing – Specialized Face Profiles
• Available In Gapless®, Napier or Conventional Styles
ap
ADVANCED PROFILING™
STEEL RINGS
Total Seal® Diamond Finish* Rings
• Axial Tolerances of +/–1.27 Microns
• Improved Sealing Between Piston and Piston Ring
• Optional PVD Coatings
• Custom Axial Thickness Down to 0.6mm
• Available In Gapless®, Napier or Conventional Styles
Total Seal® Gapless® Top** or 2ND Rings
• Increased Horsepower and Torque
• Wider Torque Curve
• Longer Engine Life – Fewer Teardowns
• Improved Consistency – Longer Ring Life
• Cleaner, Cooler Engine Oil – Better Oil Control
• Less Friction – Increased Horsepower
• Increased Intake Signal – More Engine Vacuum
** Patented
Home of the Gapless® Piston Ring
Total Seal® pioneered this horsepower producing technology over 40 years ago and has been perfecting it ever since. Available in both our patented Top or 2nd ring applications.
If you've got a ring problem, we offer the technical expertise and assistance to help give you the Total Seal® horsepower avantage!
Available from:
Total Seal, Inc.
www.TotalSeal.com
800-874-2753 (U.S.A.)
Tech Line: 623-587-7400
TOTAL SEAL®
PISTON RINGS
Total Seal, Inc.
Phoenix, Arizona
UK distributor:
PERFORMANCE UNLIMITED
Phone +44 (0) 1904 489332
Fax +44 (0) 1904 488355
e-mail info@performanceunlimited.co.uk
www.performanceunlimited.co.uk
* U.S. Patent No. 6899595, U.S. Patent No. 7207870, U.S. Patent No. 7267602


Ferrea
RACING COMPONENTS
SUPERIOR
Craftsmanship and Quality for OVER 45 YEARS!
From Sketch to the Race Track...
Our valves are ranked #1 in quality, developed with the latest state of the art technologies that produce superior race proven components. If you need a special custom valve manufactured, whether it's high quality stainless steel or US Spec. Military Titanium grade material, we can manufacture low quantities within 7-10 days.
Only trust the valves with the Ferrea name.
Download your QR Reader app to your smartphone to scan our code for more exclusive information.
Ferrea
LIGHTER | STRONGER | FASTER = MORE POWER
FOLLOW US ON:
FERREA RACING COMPONENTS
Tech Line: 954-733-2505 • Toll Free: 888-733-2505 • www.ferrea.com


PMi
PERFORMANCE MOTORSPORTS
EUROPE
One Company. One Solution
PMI Europe B.V. is located in The Netherlands and the European hub of Performance Motorsports Inc of the USA which owns the brands shown below. PMI Europe B.V also distributes ARP, Cometic and Carrillo to serve you as a one stop supplier.
New!
K1 Cranks & Rods
ARP Bolts & Studs
Innovate Motorsports
Cometic Gaskets
Wiseco Forged Pistons
Carrillo Rods
Innovate Motorsports Diagnostic equipment (AFR-OBD-II)
INNOVATE MOTORSPORTS
WISECO Performance Products
K1 TECHNOLOGIES
CARRILLO
ARP automotive products
COMETIC GASKET
PMI Europe BV
Pesetaweg 32
2153 PJ Nieuw Vennep
The Netherlands
Tel: +31 (0) 252 680437
Fax: +31 (0) 252 684643
Email: info@pmi-europe.nl
Web: www.pmi-europe.nl
PMi
PERFORMANCE MOTORSPORTS
EUROPE



FIRST PRINCIPLES

Databytes gives insights to help you improve your data analysis skills each month as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems. Plus we test your skills with a teaser each month.

To allow you to view the images at a larger size they can now be found at www.racecar-engineering.com/databytes

Memory sticks

Even the greatest drivers can do with a helping hand sometimes, notably in their recollections of a race...

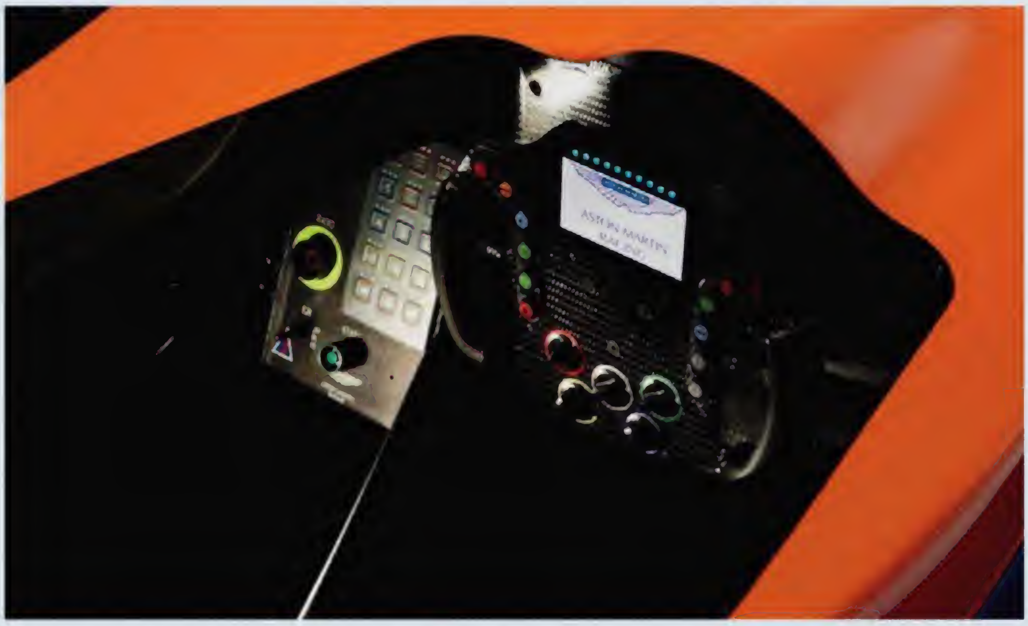
Modern racecar drivers have quite a lot to do in the office. Not only do they have to navigate the vehicle at high speed around a circuit, they are also responsible for looking out for any possible signs of trouble with the racecar, as well as adjusting various mechanical and electronic devices, and maintaining communications with the team on the pit wall. This means that when it comes to a debrief, there can be many details the drivers need to remember, such as what was the position of the anti-roll bar on the fastest lap, what was the brake balance, was there traffic etc. Given that all that is going on at great speed, it is extremely useful to be able to supplement the driver's memory by monitoring all the auxiliary actions of the driver.

Brake bias, for example, is adjustable in most cars, and therefore it is important that this be measured in order to get the most out of the adjustability. This is relatively simple to monitor with front and rear brake pressure sensors and a simple maths channel to present the actual balance between the front and the rear of the car. Using this information effectively can help deliver improvement in braking performance. Many race cars also have driver-adjustable anti-roll bars, so it's a good idea to monitor the position of the adjustment lever to make sure the balance adjustment is optimised.

In more complex racecars equipped with high end data and electronic control systems, this information can be sent and received in a number of different ways. If, for example, there is a rotary switch to choose different engine maps or differential settings, the signal from that switch can be sent to both the ECU and the data logger so there is a permanent record of what positon was selected at what time. The same applies to any control that is available to the driver on the steering wheel.

> **"It is extremely useful to be able to supplement the driver's memory"**

But what other gains can be had from monitoring these driver inputs? Modern data logging systems can be used to control a display for the driver and many also allow maths channels to run live on the system. Having this capability opens up some interesting options. For example, the simple function of pushing the pit lane speed limit button can also be used to trigger a timer. This is extremely useful in a situation where a car must be in the pits for a set amount of time as the timer can then be put on the vehicle display, so the driver knows exactly when to exit the pit box to minimise the time spent in the pit lane.



Modern racecar steering wheels are a maze of buttons, giving drivers plenty to think about while also driving the car

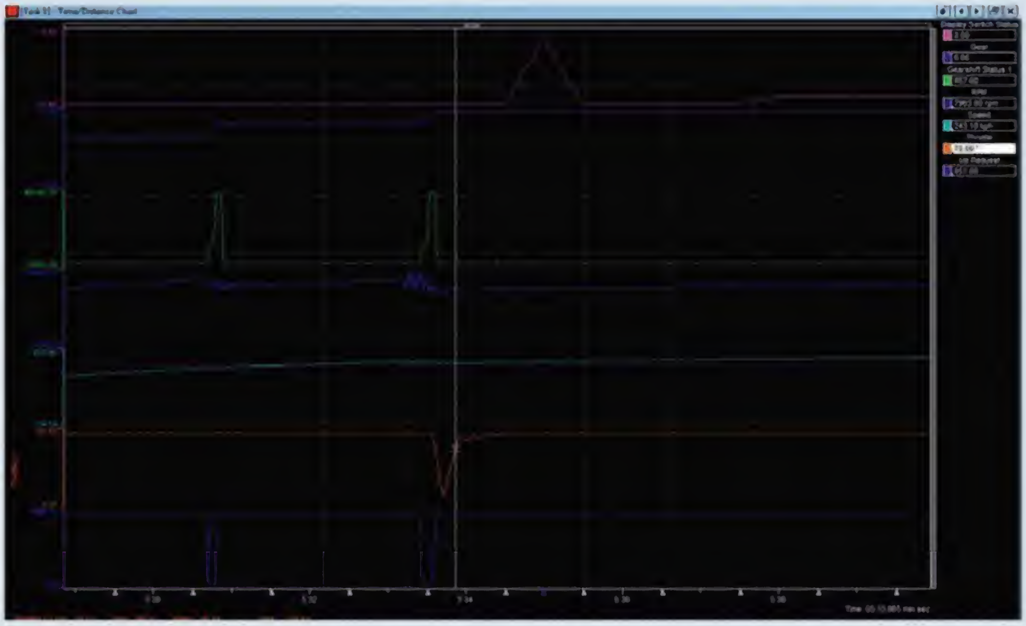
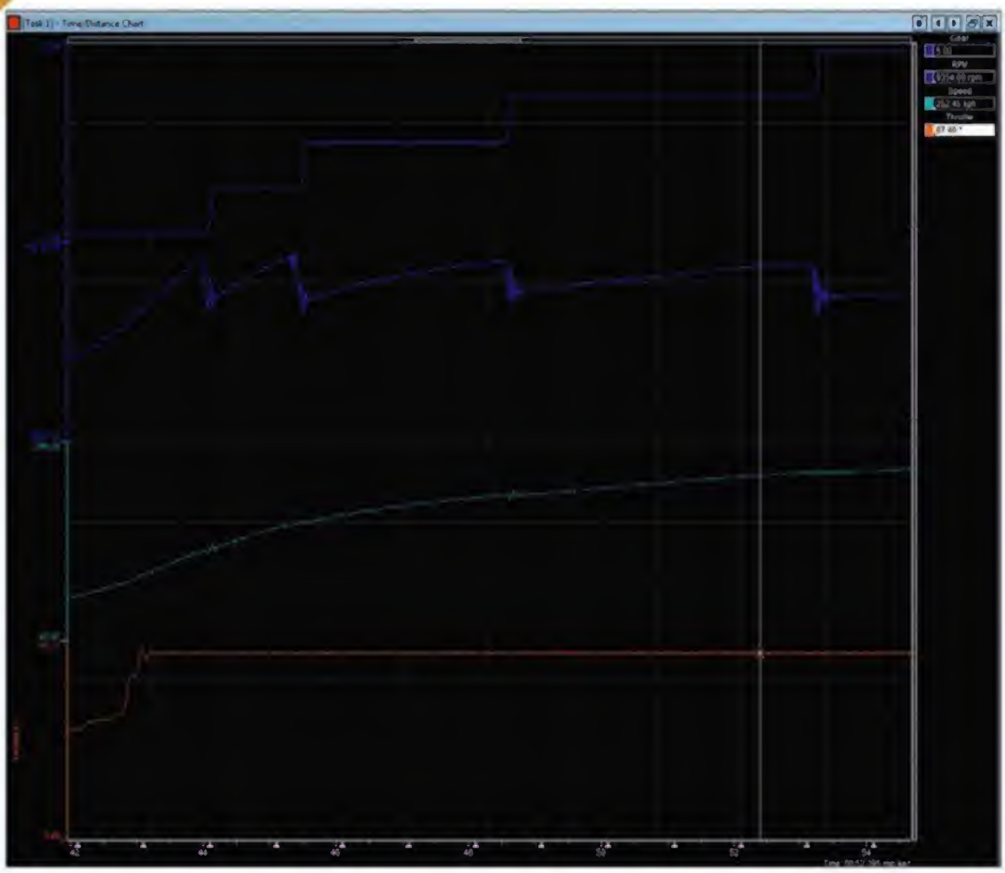


Figure 2: an example of a driver using a marker when an unusual behaviour was seen in an up shift. The driver comes off the throttle for a very short period during the shift and inserts a marker (pink) in the data set as a reminder

Another interesting and useful feature to have is a general marker button on the steering wheel. This does not necessarily need to be a separate button, but can be used by the driver to mark a spot in the data set when a particular event occurred. For example, if the driver experiences a missed shift or dog-to-dog during a gear change, it can help speed up analysis to know exactly where in the data to look. This makes trouble-shooting and fine tuning the racecar easier and more focused.

Such auxiliary driver inputs can be very useful, but they need to be carefully implemented in order to make the most out of them. Used correctly, there could be advantages there that can help make the car go faster.

CHALLENGE



Test your data analysis skills with this challenge set by the data engineers at Cosworth

Question:
The driver has reported a strange feeling when changing gears, but is unable to clarify further what the feeling is. What could possibly be going on?

Find the answer online at www.racecar-engineering.com

COSWORTH

Produced in association with Cosworth
Tel: +44 (0)1954 253600
Email: ceenquiries@cosworth.com
Website:
www.cosworth.com/motorsport


McLaren
ELECTRONIC SYSTEMS
RACE TO CONTROL
CONTROL SYSTEMS
• Formula One
• IndyCar
• NASCAR
ACQUISITION & TELEMETRY
• High speed data loggers
• Configurable CAN
• High bandwidth telemetry
DATA SYSTEMS
• ATLAS: F1, Indycar, NASCAR, Le Mans
• vTAG: real time simulation platform
DEVELOPMENT ENVIRONMENT
• Model based applications for embedded and PC environments
WWW.McLARENELECTRONICS.COM


The Most Trusted Name In Racing Clutches
There is a reason the world's top racers put their trust in Quarter Master® driveline products. With the industry's most in-depth testing program and continuous investment in the latest computerized design and manufacturing processes, Quarter Master® superior product backed by "racer friendly" product support.
Pro-Series Clutches
The staple of the Quarter Master® clutch line-up, the Pro-Series is proven to offer unsurpassed performance and durability for demanding road racing applications.
• Race-Tested Design Is A Proven High Endurance Performer
• Closed Housing For Strength & Contaminant Protection
• Low Moment Of Inertia & Exceptional Race Durability
• 7.25" Unit Available With Steel Or Aluminum Cover
4.5", 5.5" & 7.25" Dia.; Single, Dual & Triple Disc Units Available
Single & Dual Disc Units Available
7.25" Rally V-Drive Clutch
A specially engineered version of the race-proven V-Drive clutch tailored to handle the rigors of rally & road racing. This clutch utilizes thicker frictions (.250" thick versus the normal .104") to withstand the punishment of a grueling off-road environment.
QUARTER MASTER®
Tech & Sales: +1 847.540.8999
quartermasterusa.com

Confidence tricks

As motion-based simulation breaks into top-flight racing, diverse solutions compete to become the industry standard

BY CHARLES ARMSTRONG-WILSON

It was 15 years ago that Jacques Villeneuve raised eyebrows in Formula 1 by learning the whole season's circuits on a computer game. It was entirely in character with his baggy pants, skater image, born out of a culture where computer games were taking centre stage. And it worked, helping him win four races in his rookie season.

But it took more than a decade for simulations to embed themselves in the arsenal of the F1 teams. In the last couple of years, though, their relevance has taken a huge leap, thanks to motion-based simulation, which is widely believed to engage with the driver on a much more intimate level, and consequently is being used by most F1 teams - but not all.

There is a contrary attitude that if you cannot reproduce the forces in a real F1 car, then there is no point trying at all. In fact, in attempting to simulate the forces, you risk misinforming the driver, which would ultimately be counter-productive. Furthermore, some highly respected drivers are even, we are told, prone to motion sickness when driving a force-based simulator.

However, the fact that most F1 teams do now use motion-based simulation supports the argument that it can provide a valuable aid to driver training and car development. But the debate over what forces are regarded as necessary, and how they are best applied to create a worthwhile simulation, is far from settled. The technology is still very new and various approaches are emerging from different suppliers. This, then, would appear to be an exciting time for the technology. The different solutions are based on the differing views held by the people behind them so, to understand it better, we spoke to three companies with different simulator formats for their insight.

CRUDEN

Tracing its roots back to a department of Dutch aircraft manufacturer Fokker, the experts that formed Cruden began life creating simulator technology for

Toyota Motorsport's F1 simulator in Cologne, Germany, the highest spec commercially available simulator of its type

training pilots. This allowed it to develop expertise with control systems and force loops and even to start selling its technology outside the company. Then, when Fokker hit financial problems in 1996, the staff of the simulator department recognised its commercial potential and completed a successful a management buy out.

By 2001, the company was starting to supply technology for automotive simulation. It soon realised that, unlike flight simulation, there were no other suppliers in the market. So, rather than supplying retailers of simulators, it started selling simulators direct into the automotive industry.

With vehicle dynamicists and image generation expertise in-house, it was soon supplying turn-key solutions to research institutes and universities. Now it also has several F1 teams and major motor manufacturers on its customer list and, from this position as a supplier of professional simulators, has since branched out into the

Cruden's Hexatech motion platform offers six degrees of freedom and forms the basis of more advanced simulators

entertainment market.

All Cruden's simulators for industrial use are based on the Hexatech architecture, comprising six actuators that connect the triangular base with the top platform. Crucially, as commercial director, Frank Kalff, points out, it offers six degrees of freedom. These are three linear modes along the x, y and z axis and three rotational modes around those axes.

'Without it,' he asserts, 'you cannot excite the vestibular system in your brain to trick it, because that is what you are doing in a simulator, to believe you are doing what you are not doing. You trick the driver into giving information to his brain through all the sensors he has, which include haptic sensors, hands, bottom, shoulders, audio and visual. All these things are sensors - they capture information and send it to your brain. That then determines what you see but, more importantly, what you feel.'

Kalff concedes that you cannot recreate all the forces and movements of a real racecar, at least not without spending a phenomenal amount of money and using a huge amount of space. However, he explains that, by introducing perceptual cues into the picture, drivers create their own internal image of the world.

The illusion begins as the virtual car sets off. The platform moves forward to give an initial feeling of acceleration, but it can't keep moving because it runs out of travel, so it then tips backwards under the perception of the driver until it uses gravity to keep that feeling of acceleration.' With the Hexatech arrangement, the platform can be moved around a virtual centre above the driver's head, allowing the inertially-induced feeling of acceleration to be seamlessly transformed into the gravitational pull.

"You trick the driver into giving information to his brain through all the sensors he has"

Meanwhile, it is feeding in little vertical movements to give the feeling of the car moving over a road surface. These speed up as the car accelerates to tell the driver he's going faster. Combined with the sound of rising revs and the movement of the image on the 'screen, it stimulates the driver's senses to create the illusion of an accelerating racecar.

The same principles apply to braking and cornering. But when creating a useful tool for

Force Dynamics 401CR simulator can revolve continuously in either direction

professional motorsport, rather than just a game platform, things become much more complex. 'Racing drivers don't like large amounts of pitch or roll,' reveals Kalff. 'They are very susceptible to any change of acceleration and all have a very low threshold for influences on their body. For instance, if you consider a chicane. Using *g*-tilt, he does not feel the *g* force on his body, he feels the platform tilting sideways, backwards or forwards. They pick that up very quickly and say, "I don't want this. You are tilting my head all over the place." So we cannot use that to the degree we would use it in entertainment, or at shows where the non-professionals that sample our technology don't have that threshold.

'So you need the yaw. You need a slight amount of roll - just two or three degrees. I know that sounds like very little, but to these drivers it's everything. It's often small movements, but if you don't have them they don't have enough cues to judge what they're doing. It's the change in the direction and, if you don't have all the six inputs, you cannot fool the brain well enough to make the drivers feel it's realistic.'

The Hexatech platform's flight simulator heritage has led some to question whether it can handle the high-frequency inputs generated by a racecar model. But Kalff is adamant that it can. 'The output of vehicle models from automotive and motorsport teams is around the 17-18Hz mark. Our standard system can handle that as it goes up to 20Hz, but our bespoke professional systems can go up to 40-60Hz.

'The visual input is always going to be your limiting cue. We still have TVs that run at 60Hz, so it takes 1/60th of a second to draw a new image. If you don't change the image, but you do change your motion base you get motion sickness.' Kalff notes that this is a fast developing science. 'There is a vast amount of parameters you can change: limits; gains; slew rates; rate limiters; band widths; filters. But you have to start with an understanding of how the brain works and what information it needs.'

Kalff points out that such complexity is not cheap. 'We don't make games. The equipment we make is what they need to do what they want to do, and that costs money.' A Cruden motion platform as used for entertainment, for example, starts at around 100,000 euros (£87,750 / $141,450), and the image projection required by some motorsport teams costs at least another 100,000 euros.

“Regardless of how mathematically correct a system seems, unless it engages the driver, it's not going to work”

FORCE DYNAMICS

'What is the difficulty of driving a racecar?' asks David Wiernicki of Force Dynamics. 'The thing is to get it to point in the right direction. Everything you feel about what the car is doing is around that. The rotation of the car is going to tell you more than anything else.' This is the philosophy that underpins the company's motion-based simulator design. It puts rotation at the top of the functionality hierarchy.

The company was established in the 1970s to build bespoke automated systems, mostly for manufacturing. 'That gave us lots of experience with motion control,' says Wiernicki. But when that type of work started to drift away from the company's US home territory, its directors started to diversify. Its founders were enthusiastic racers, so the link with racecar simulation came naturally.

The first simulator, the 301, was a three-degrees-of-motion platform. Mounted on three legs it could rotate around longitudinal and lateral axis and heave. Trying to come up with a fourth degree of freedom, the company mounted this on a turntable that could give +/-90 degrees, much more than the 20 degrees or so found on other motion-based simulators. 'We got in and thought, holy shit,' says Wiernicki, 'it was absolutely amazing. You could learn to correlate side forces. It made the car live.'

Impressed with the success of this, they have now made the 401CR (CR for continuous rotation), which can revolve continuously in either direction. 'With a small yaw angle, by definition the simulator has to keep returning to its centre position,' explains Wiernicki. 'With a small excursion angle - say, +/-20 degrees - this has to happen quite rapidly. So what happens is that by definition the simulator is turning the wrong way half the time. No matter how subtle your washout is, you either have to 'crush' the motion output so much that you're getting only a small percentage of the real movements, or turn up the speed of the washout so much that you can feel the deltas as the machine changes direction.

'People will swear you don't need a large excursion angle, but our experience is different. Where you would expect it to work or not work is oval racing and we got some good feedback from Stock Car drivers. Also from World Rally level drivers who drove it with yaw. As soon as I turned it off they went off the road instantly.'

Originally, the target market was entertainment, but the company has found a growing demand for simulation applications. Force Dynamics does not write its own simulation, so the machine is designed to work with other company's products. By keeping it simple, they have produced a device that is both very responsive and cost effective. According to Wiernicki, response times are down to 10ms and prices start at $85,000 (£52,700) for the continuous rotation machine or $65,000 (£40,300) for the 90-degree yaw version.

The simplicity also makes it compact so it can be moved around on a standard fork lift

SIMCRAFT APEX

Recognising the severe limitations of the old hexapod method of motion simulation, in 1997 SimCraft's founder conceived a simplified fixed axis, constant c of g, low inertia approach.

SimCraft's APEX technology focuses on exposing drivers to high-fidelity representations of the key vehicle dynamics they need to experience to connect with the virtual environment. Its independent axis structure, with fixed mutually perpendicular axes of rotation, distinguishes it from the hexapod-type systems. When coupled with SimCraft's control software, it creates real feelings of understeer, oversteer and tyre adhesion limit.

APEX systems also reproduce vehicular kinetics (all bar *g* force), offering a natural feel and real-time adjustability, while the adaptability of SimCraft's software allows for applications in all levels of motorsport.

Five-time rally champion and rally school owner, Tim O'Neil, who uses the SimCraft system had this to say about it: 'The independent axis motion of the APEX, particularly the yaw capability, has proven very valuable in training car control technique in high speed, loose-surface driving. The main USP's compared to a big platform is better fidelity, versatility and value. It provides a more organic feel with low infrastructure demands and reduced costs.'

Gemma Hatton

pallet and set up in an office environment. It can work on the power from a normal wall socket and the simplicity applies to the data processing, too. There has to be some filtering to remove the granularity of the digital data feed but, with the yaw input, angle equals angle so there is no complex processing to be done.

BRD

'We are not replicating, we are simulating,' says Tim Ball of Ball Racing Developments. He makes the point that you cannot reproduce the loads experienced in a racecar without using an enormously large and complex simulator, and that is not necessarily what is required anyway. 'It's about engagement of the mind,' he explains. 'In some areas there is no way you are going to be able to replicate reality, so you have to trick it. Sometimes it can be the small things, such as the vibration of the engine and the noises. If your brain doesn't have all those things then it can quickly disengage.'

The BRD simulator platform predominantly operates in two planes, longitudinal and lateral, with tooted belts driven by servo motors moving the tub in the horizontal planes. This simplifies the task of generating *g* forces but, when the travel runs out, there is no transition to gravity taking over. However, Ball believes this is not a problem. 'It's all about confusing the mind and, if the mind is correctly confused, you have the sim right.

'We cannot maintain high *g* but it's about change of g rather than sustained *g*. We found drivers like the raw sensation, the engagement.' This informs all his thinking on simulation and it seems that once you relinquish the desire to replicate reality, it is very liberating. 'Regardless of how mathematically correct a system seems, unless it engages the driver, it's not going to work.'

What Ball likes about the separate planes of motion is the ability to build the simulation in layers. He claims it makes the processing simpler and improves response times.

BRD came to simulation through the entertainment route, providing rigs for corporate hospitality. These were originally static, but soon started to incorporate features like steering feedback. Early motion experiments involved wheeling a blindfolded driver around in a tub on castors to see what drivers were able to experience. But they eventually extended to running their own Formula BMW team to

Ball Racing Developments' (BRD) Pure Tech Racing centre in the UK offers a multi-driver simulator experience, with minor yaw and vertical movement

collect data and inform the development process.

The latest version can now yaw and deliver a small amount of vertical movement to help cue a pitch response in the driver. These are used in BRD's latest venture, the Pure Tech Racing centre at Horley, UK, where 10 simulators are hooked up to create a full race experience against other competitors. It may be unashamedly entertainment but the aspiration is for much more.

The simulation can be ramped up in intensity as drivers improve and the centre has a club encouraging visitors to hone their skills. Ball believes that if drivers become proficient on the simulation, they could step straight into a wings and slicks single seater and be competent on a real track.

BRD supplies simulator technology to the motorsport industry, right up to Formula 1. Currently, a Formula 3 standard simulator would cost between £110,000 and £120,000 ($177,300-$193,400), depending on the visual system specified by the customer.

Cranfield Motorsport

How sensory cues can be used to trick the human mind and body

The research department of Cranfield University has moved into the simulation market with a new patented technology, designed to trick a driver's mind and body into feeling as though it is in a real racecar. Launched in May 2011, the system is already proving popular and is being investigated by a number of F1 teams.

Cranfield Motorsport Simulation provides the driver with a range of carefully co-ordinated 'cues'. The primary sensory cues come from the visual display, and these provide the brain with a large amount of information on the surroundings and the vehicle motion, relative to those surroundings. A 'first level' simulation is achieved when the visual inputs are augmented with co-ordinated aural inputs and force feedback to the muscles.

Within the simulator, the vestibular and visual systems must be stimulated to induce the perception of self-motion. This is enhanced if the tactile systems of the body and the driver's auditory system are also stimulated. In the racing environment, the important loads are experienced in the longitudinal and lateral directions, whereas in flight the largest loads are in the 'normal' (vertical) direction. This fundamental difference is a result of braking and cornering, where lateral loads of up to 4-5*g* are commonly experienced. To provide effective motion cueing, it is also necessary to consider the effects applied to the whole body, in particular the upper torso, with longitudinal acceleration / deceleration and lateral acceleration cues to simulate tyre slip, cornering and vibration. These cues are provided in three distinct ways:

Eye position movement (kinaesthetic).

Sustained pressure (somatic) cues from actuators placed around the seat bucket, as well as harness tension variation.

True vibration cues, based on real vehicle data, are put in via an ethernet connection. Aerodynamic buffeting, engine vibration, track and tyre variations and other vibration-based cues can also be applied.

SUSTAINED MOTION CUEING

Cranfield provides a series of onset and sustained cues. It combines the onset cues offered by a motion platform with sensory stimuli to the driver to represent the forces experienced on the torso and legs whilst driving the racecar around a track. The Sustained Motion Cueing System (SCMS) is situated in and around the monocoque, with actuators in the driver's seat structure, at those points where the driver experiences pressure as a result of the forces induced by high-speed driving. The cues provided by the SMCS are progressive (proportional to relevant *g* demand) and sustained until the demand is removed.

In braking, the driver will feel as if he is being forced into the seat pan and feels an increase in harness tension. In longitudinal acceleration he will feel as if he is forced back into the seat and in cornering he will feel pressure to his torso as if he is being forced into the side of the seat / monocoque. All of the above are sustained cues and impart forces upon the driver according to the desired *g* loading.

It could be the technology needed to help drivers make the step between the simulated world and the real world.

Cranfield University's simulator uses patented technology to fool the driver's brain and body into thinking it's having a real race experience


CRANFIELD
MOTORSPORT SIMULATION
Whether you are a privateer racing driver or an entire race team, the Cranfield Motorsport Simulation (CMS) range of products and services offer you the most powerful off-track training aid in the market today.
CMS provides a complete range of personal training services and development tools or if you require it, provision of a complete training device tailored to meet your individual needs.
Contact us to book our dedicated simulation facility or to discuss the purchase of one of our off the shelf or bespoke product solutions.
+44 (0) 1234 754 099
graham@cranfieldmotorsportsimulation.com
www.cranfieldmotorsportsimulation.com
INNOVATION IN SIMULATION


TK
T&K PRECISION LTD
www.tkprecision.com
Specialist manufacturers to the Motor Racing Industry
+ Family owned and run business providing a total nationwide service to the motor racing industry
+ Complete part manufacture plus turning, grinding and milling of components
+ High tolerance, fast turn-around Thread Rolled Studs and Fixings made complete for Formula 1 and Indy Cart Series engine manufacturers
+ Exclusive suppliers to GT Endurance and British Touring Car teams
+ Wide range of specialist materials including Titanium and MP35N
+ Complete ISO 9001-2000 accreditation, fully computerised production systems and 10-year lot traceability of all bought-in materials
Please call or e-mail for a copy of our brochure
01604 493101
e: sales@tkprecision.com
T & K Precision Limited
9-10 Gatelodge Close
Round Spinney
Northampton NN3 8RJ

Arden International

Homemade GP2 simulator offers huge advantages to drivers and engineers alike

Christian Horner's GP2 team, Arden International, is one of a growing number of lower formulae outfits with its own simulator. Unusually, though, the team has developed its own from scratch, using real GP2 and GP3 data, whilst most commercially available simulators use Formula 1 or Le Mans Prototype data.

'We slowly built our simulator up with a steel spaceframe chassis, one screen and just your basic Playstation-type steering wheel,' explains Campbell Hobson, who heads up the programme. 'Those guys who used it thought it was useful, especially for running rookies, as with the GP2 race format drivers do not get a lot of time in the car - half an hour practice and then half an hour qualifying - and our guys were going to circuits they'd never been to before. We felt that we could give those guys an opportunity to get used to the right gears and the circuit layout, which would be beneficial.'

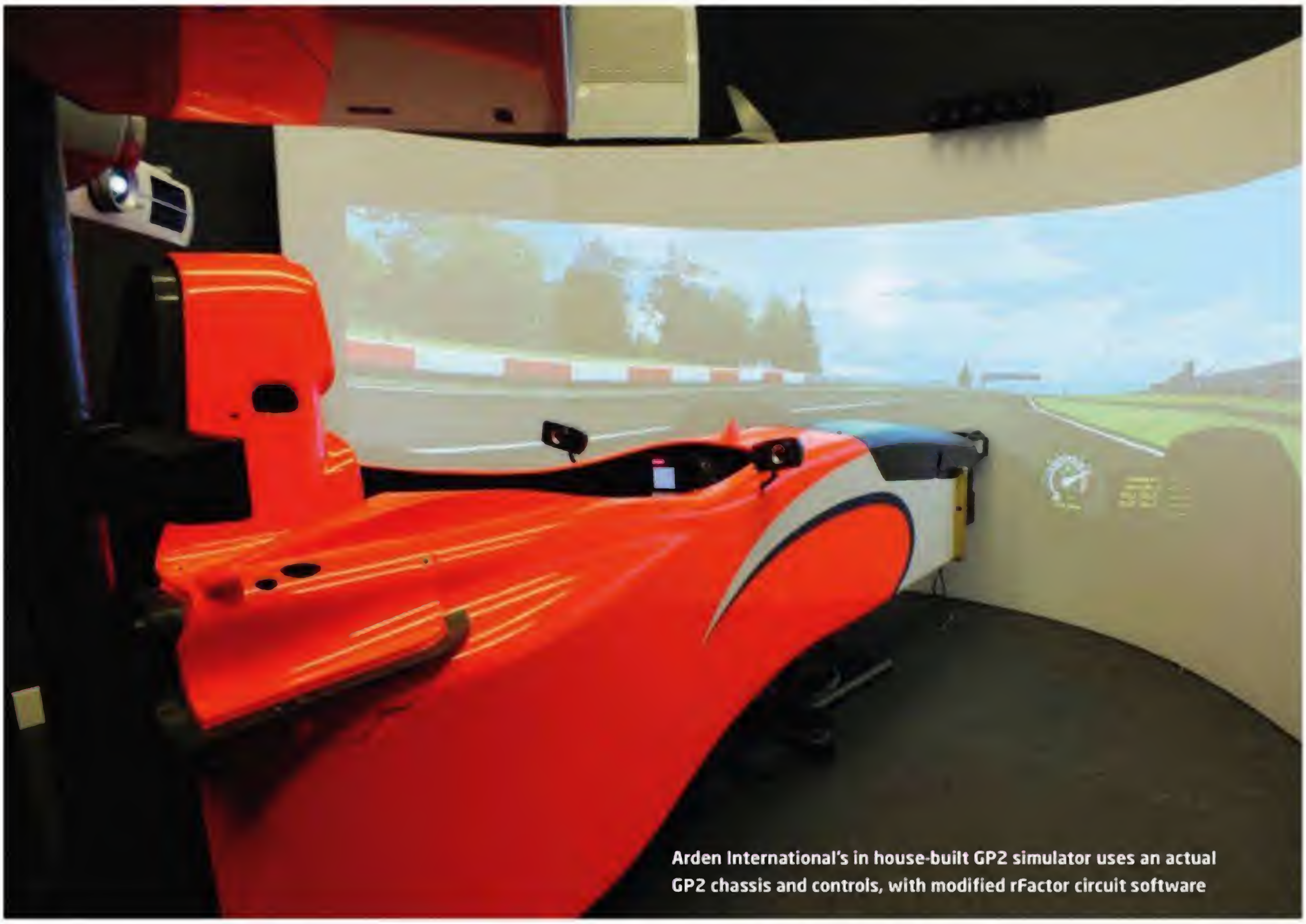
As the simulator developed, Arden moved from a simple tube frame to an old F3000 chassis, and then onto a second, more advanced simulator based on GP2/05 chassis 013, which was used by the team in the early days of the series. The new simulator features real GP2 pedals and a solenoid-controlled platform with a genuine GP2 hydraulic braking system. The steering wheel is a 2008 model with paddle gear and clutch shift.

The system is based on the popular racing title rFactor but with the physics modified to give the driver more realistic feedback, and it has been validated against real car data.

'We run on a modified version of the standard software,' reveals Hobson. 'We don't have quite the full capacity of rFactor Pro, but we feel that the only thing we possibly miss out on is being able to use laser-scanned circuits. Those go for around £20,000 a circuit so we're not going to be able to afford them anyway so it doesn't matter. For us, the standard circuits that come with rFactor are good enough. Now and again we can get them modified by people for a very reasonable price - for example, if we want a kerb put in or a barrier removed. Or we can adapt the kerbs ourselves if the drivers are saying, "no, those kerbs are way too big, it throws the car off." We can change the grip of the kerbs, the height, all that kind of stuff. So we can do quite a lot ourselves, in house, which obviously saves us a huge amount of money and it saves us time as well.'

The simulator uses three projectors to provide a screen width of 16ft (4.88m) that fully engulfs the driver in the simulation environment. Steering feedback is achieved with an electric motor and custom motor controller working at 400Hz. The motor is powerful enough that even the GP2 steering loads require only 80 per cent of the motor's capacity.

The Arden engineers increasingly rely on the simulator to help drivers achieve a good car set up and to ensure they will be confident at a circuit, even without having ever visited it. 'Going into testing, we've had GP3 guys who were doing a test with us in Abu Dhabi and just getting them used to how hard to hit the brakes. It's quite a surprise for them, but simple things like that are a huge advantage,' concludes Hobson.



Arden International's in house-built GP2 simulator uses an actual GP2 chassis and controls, with modified rFactor circuit software

Hope springs eternal

Taking on the Japanese in their own back yard was never going to be easy. But that's what Mosler Europe did. And it spawned a new 'SuperGT' product

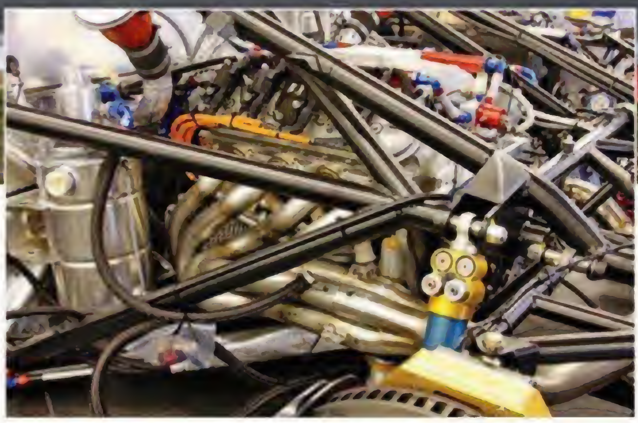
BY SIMON MCBEATH

This is not the place to debate the problems endured by Mosler in the USA and in Europe in attempting to get the MT900 accepted in mainstream GT racing, but one of the outcomes of that battle was an even greater determination to succeed. And from this sprang the idea of building a new, cheaper, quicker version of the car.

Mosler Europe CEO, Martin Short, a driver and team owner of considerable repute, set about putting together a business plan to get the car racing. 'With our Mosler GT3s being 'equalised' to the back of the grids in Europe, we needed to look elsewhere,' says Short. 'There are certain championships that work on a power-to-weight ratio system, rather than the restrictive GT2 / GT3 format. This allows car designers more freedom. With that in mind, we decided to work on advancing the aerodynamics of the car, and improving chassis stiffness.

'From some basic CFD aero development work we knew the areas where we could gain most with this car. The floor offered the biggest potential for creating downforce, but it needed to be driven harder by a different diffuser at the rear. And to get the new diffuser shape we wanted, we needed a new rear chassis design. Whilst we were doing that, we decided that we may as well design a whole new spaceframe chassis - a backwards step perhaps in some ways compared to the GT3 car, but it allowed easy aero tweaks, along with reduced costs from the road car's carbon composite honeycomb tub employed on the GT3 cars.'

Coincidentally, at around the same time (2009), Singaporean businessman and racing driver,



Team ThunderAsia

Main picture: the Mosler GT300 in its new home in the Super GT
Inset top: GT600 version was a development of the GT300 following the allowance of GT3 cars into the Super GT3000 category. The car ran with a Chevrolet LS7 engine, rather than the regulated 300bhp Judd XV
Inset middle: with the raised rear chassis of the GT600, a bigger diffuser was possible. Note the Chevrolet engine's exhausts exit at the rear
Above: in the GT600 version, the Chevy LS7 fits snugly

Melvin Choo decided to become the first foreign entrant in the Japanese Super GT Championship. 'Melvin bought a Mosler GT3 car in 2009 and did the SuperGT race at Sepang with me partnering... [then] did further Asian GT3 races, and from this came the idea of a new SuperGT car using our at the time concept 'Mosler Cup' car,' says Short.

Discussions with ThunderAsia's team director Raja Zaini ensued. 'The team loved the car's looks and the tube frame concept struck a chord. So the finance was put in place but, as is invariably the case, time was tight. And because the budget was not big, our instructions from Raja were to spend sensibly, as if I was building the car for myself,' recounted Short.

> "there's nothing wrong with an 'old tech' spaceframe"

ENGINE CHOICE

One of the key questions at the outset was which engine to use. Short contacted John Judd at Engine Developments about the XV engine, knowing that a replacement was on the cards so terms might be favourable, and also because Short had personal experience of it in the Radical SR9 LMP2 car he had driven under his Rollcentre Racing banner. A deal was struck, but that then led to the matter of installation. 'RML sold us a beautiful ex-Lola bellhousing, which saved us thousands and solved that particular issue,' said Short. The gearbox effectively chose itself, Short having used the Hewland NLT for some eight years and found it to be inexpensive and he also knew there were plenty of ratio choices available for it. Just the adaptor plate was bespoke, and the input shaft and final drive were also altered to suit.

The engine had to breath through its JAF (Japan Automobile Federation) mandated twin 23.8mm restrictors to run in GT300. Short: 'We all thought it was a 300bhp formula, and Judd calculated we would have just over that, so that's what we rather naïvely worked to, only later discovering that more like 350bhp was needed... So the car arrived in Japan breathless. Judd worked hard within the constraints, but all there was time for was to alter the inlet trumpet length and make a few mapping tweaks to give the engine some torque.' The engine also had to run JAF-

The position of the airbox required a bespoke design, which was modelled in CAD and laid up by carbon composite experts Reverie

Cranfield graduate Ling Xiao refined the 3D CAD model so it could be run through CFD, a process that greatly sped up the design stage

Double wishbones front and rear are used with outboard spring dampers

CFD project undertaken with TotalSim yielded benefits. Here we see streamlines viewed from the front of the car

specified catalytic converters, but no silencers.

The long inlet trumpets and the requirement to retain the standard engine inlet location called for a bespoke airbox, which, together with the rear wing, was laid up by carbon composite experts, Reverie, from moulds machined in tooling block directly from a CAD model by Concept Tooling.

The suspension layout was carried over from the GT3 Mosler. 'We could have gone to pushrod suspension but we tried to stick basically with what we knew, given the timeframe and knowing the 'standard' car handled nicely. It also eased the parts supply issue, as we started out thinking this would be a one off...' said Short.

COST-EFFECTIVE AERO

Following a visit by the writer that highlighted areas where the Mosler's aerodynamics would benefit from closer attention, Short contracted TotalSim to carry out a CFD analysis and optimisation project. 'We had taken on Ling Xiao, who had just gained his motorsport engineering MSc from Cranfield, and he took this project on at our end, refining our 3D CAD model so it could be run through CFD. And as a cost saver he made the geometry changes recommended by the TotalSim engineers on the fly at TotalSim's offices. Between them, TotalSim, Ling and the project leaders at Mosler - Michael Tallentire and Luke Kendall - worked through the JAF GT300 regulations and came up with some new ideas, such as the box sections on the rear wings (fenders), which hadn't been used in the series before. Ling's 3D skills were essential to this project. The car probably wouldn't have happened on time without his hard work.

'We checked everything with the JAF, who were very helpful and gave us the nod on our new ideas. They even commented on the rear wing being quite low and asked if we wanted to raise it. But its profile, which we designed, was optimised for the regulation height. It might have been useful to know earlier that we could have raised it though... At times, the regulations did seem to be a moving target, but Raja and the JAF worked together well, and we got through all the issues,' explained Short.

The team had originally drawn up a pair of large front diffusers, aft of which the chassis featured a ship's bow-shaped divider ahead of the front compartment rear bulkhead. The CFD project showed that even with exits aft of the front wheels, the bulkhead was preventing effective air egress and that a simpler, smaller front diffuser set up actually performed better. Further gains were found with a shaped radius on the splitter leading edge. To avoid the use of costly composites in this vulnerable component, the splitter was made from a marine ply upper half and Jabroc lower half. Other details around the wheel wells and rear bodywork produced worthwhile gains in downforce, with overall a drag reduction compared to the GT3 car.

DOUBLE CRASH TEST

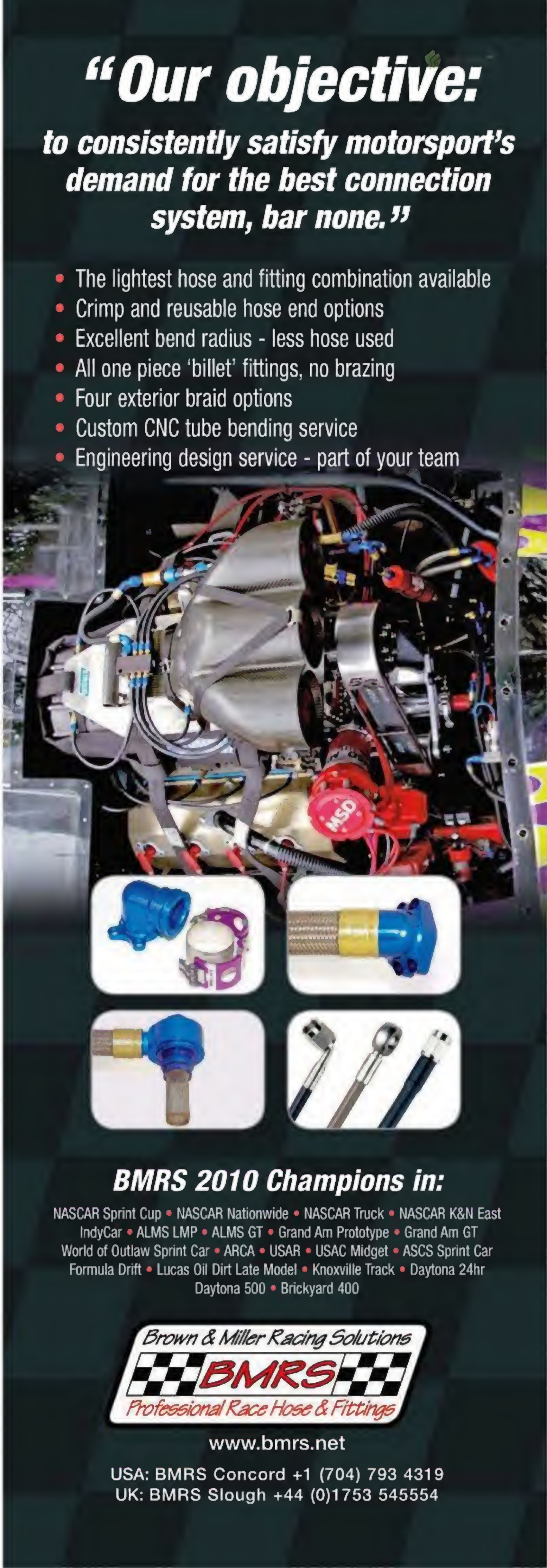
The mandatory crash tests were carried out at the Cranfield Impact Centre in the UK, and so great were the energy requirements that the test had to be done in two hits, literally, and the combined results added together. It passed.

Unsurprisingly, considering Short's original business was manufacturing racecar rollcages, the tubular spaceframe was made in-house. 'It's probably over engineered,' he admits 'but we knew from a TVR Cerbera we built and ran in 1999 that there's nothing wrong with an 'old tech' spaceframe, you can get massive torsional rigidity numbers.' The standard Mosler features a carbon composite chassis with front and rear subframes bolted to this, and the expectation was that losing these bolted joints, combined with better load paths, would increase overall chassis stiffness.

EARLY RUNNING

The timeframe proved too tight to make the first JAF Super GT race in spring 2010 (parts supply being the main delaying factor) but, after a shakedown test at Silverstone, the car made it to Japan for the second race. It was there the woeful lack of engine


NEXT GENERATION
DATA ANALYSIS
GDA Analysis Software
NEW
> Race proven systems
> Very high data rates
> Fully customisable
> Analysis software included
GEMS
PERFORMANCE ELECTRONIC SYSTEMS
www.gems.co.uk


"Our objective:
to consistently satisfy motorsport's demand for the best connection system, bar none."
• The lightest hose and fitting combination available
• Crimp and reusable hose end options
• Excellent bend radius - less hose used
• All one piece 'billet' fittings, no brazing
• Four exterior braid options
• Custom CNC tube bending service
• Engineering design service - part of your team
BMRS 2010 Champions in:
NASCAR Sprint Cup • NASCAR Nationwide • NASCAR Truck • NASCAR K&N East
IndyCar • ALMS LMP • ALMS GT • Grand Am Prototype • Grand Am GT
World of Outlaw Sprint Car • ARCA • USAR • USAC Midget • ASCS Sprint Car
Formula Drift • Lucas Oil Dirt Late Model • Knoxville Track • Daytona 24hr
Daytona 500 • Brickyard 400
Brown & Miller Racing Solutions
BMRS
Professional Race Hose & Fittings
www.bmrs.net
USA: BMRS Concord +1 (704) 793 4319
UK: BMRS Slough +44 (0)1753 545554

Each four-into-one exhaust system had to feed through a JAF-specified catalytic converter, but no silencer

Such was the severity of the frontal impact requirements that the test had to be done at Cranfield Impact Centre in two stages

power came to light. 'We also found out that with our '24-hour' engine we were competing against others that were using an engine per race meeting, and they were squeezing a lot more out of them,' said Short. 'But during the shakedown it was clear the car had very balanced and precise handling straight away, which was a real credit to TotalSim and the aero work. The increase in chassis stiffness was one of the biggest things I noticed in those brief few laps, and the fact that with an 'all nighter', thrown together set up, the car was good immediately.'

Raja Zaini echoed these comments: 'The drivers reported a really good handling car, but it wasn't until we got to the track with our competitors that we discovered we were struggling hugely on the straights. We could make up time under braking and into and through the corners, but we would lose several car lengths on every straight. So initially we were disappointed with the car's performance, but the clues to its real potential were there - it handled well, it was very responsive and the chassis was really easy to drive.'

"it handled well, it was very responsive and the chassis was easy to drive"

Short: 'Raja's team was allowed to open up the restrictors within the regulations, but it really was a struggle. Our naïvety that 300bhp meant 300bhp really came home to roost. Judd did what they could on the next engine, and Raja worked on the rule makers. Interestingly GT3 cars were then allowed into SuperGT and had the best part of 600bhp. Expecting a 300bhp car to keep up was asking a lot. The GT3 cars needed serious restrictions to compete fairly with the 'true' GT300 cars, but it took a long time to achieve some parity. More development was carried out for the 2011 season and, in qualifying at Sepang, the Mosler was the fastest car designed to the JGT GT300 rules.

Back in Europe, Mosler took the lessons learnt from the GT300 programme and built a SuperGT version of the car fitted with a 480bhp, 5.7-litre Chevrolet LS6, the standard MT900 upper bodywork and the GT300 aero improvements under the skin to enter the 2010 Britcar 24 Hours. It suffered from niggling electrical problems during the race but, in testing in early 2011, and with stiffened anti-roll bars, the car showed its form. 'After a lot of effort, seeing that we really had made a good product was very satisfying... I was absolutely staggered. We were way faster in braking and cornering, and it really brought home what happens when you stick a car to the ground properly.'

A newer version of the car has been built with what Short considers the best combination - the GT300 body and a 600bhp, 7.0-litre Chevrolet LS7 with the new Hewland LWS gearbox. 'This is the first car with the combination of chassis, aerodynamics and engine I originally envisaged,' said Short. 'I like to stick with what I know, but our latest customer, Spaniard Rafael Unzurrunzaga, is very adventurous, pushing us to look at different things. And that's been a useful lesson for me, because if you are going to progress you have to do so in all areas.'

Mosler Europe's marketing emphasis shifted from its GT3 offering to the new spaceframed, re-bodied car. 'This project is more of a passion than a business approach' conceded Short, 'because there are not that many places where you can race such a car. But it fits with Warren Mosler's original philosophy, which has always been to build the lightest, fastest car.'

And if the company can offer customers this level of performance at what appears to be outstanding value for money, it will prosper again, regulators permitting, of course...

TECH SPEC

Mosler MT900R / Super GT300 / Super GT600

Class: Japanese SuperGT 300 / Britcar / Dutch Supercar / Belcar

Chassis: tubular steel spaceframe

Body: carbon composite specialist work by KRM, airbox and wing by Reverie

Engine: Judd XV(GT300) / Chevrolet LS7 (GT600), Peter Knight inlet system, Avid dry sump system

Configuration: V8, 90 degree

Capacity: 3392cc / 7008cc

Valves: 32 / 8

Clutch: AP carbon / Tilton

Exhaust: Tanabe 4-2-1 X 2 with HJS Catalytic Converters (GT300) / Goode Fabrications, two 4 into 1, BTB silencers

ECU: EFI EURO 12 / MoTeC M800

Transmission: Hewland NLT / LWS, Shiftec paddle shit

Brakes: AP Racing six-piston monoblocs, Alcon / Bosch Motorsport ABS, Project Mu pads

Suspension and steering: double wishbones, Dynamics DSSV outboard four-way dampers, Öhlins TTX46 third damper (GT300), DC Electronics PAS

Electronics: MoTeC ADL dash , M800 ECU and PDM, OBR switch panel, Kartek master switch, St Cross wiring loom

Fuel cell: ATL, 120 litre

Fire system: Lifeline

Plumbing: Earls Superflex oil and hydraulic lines

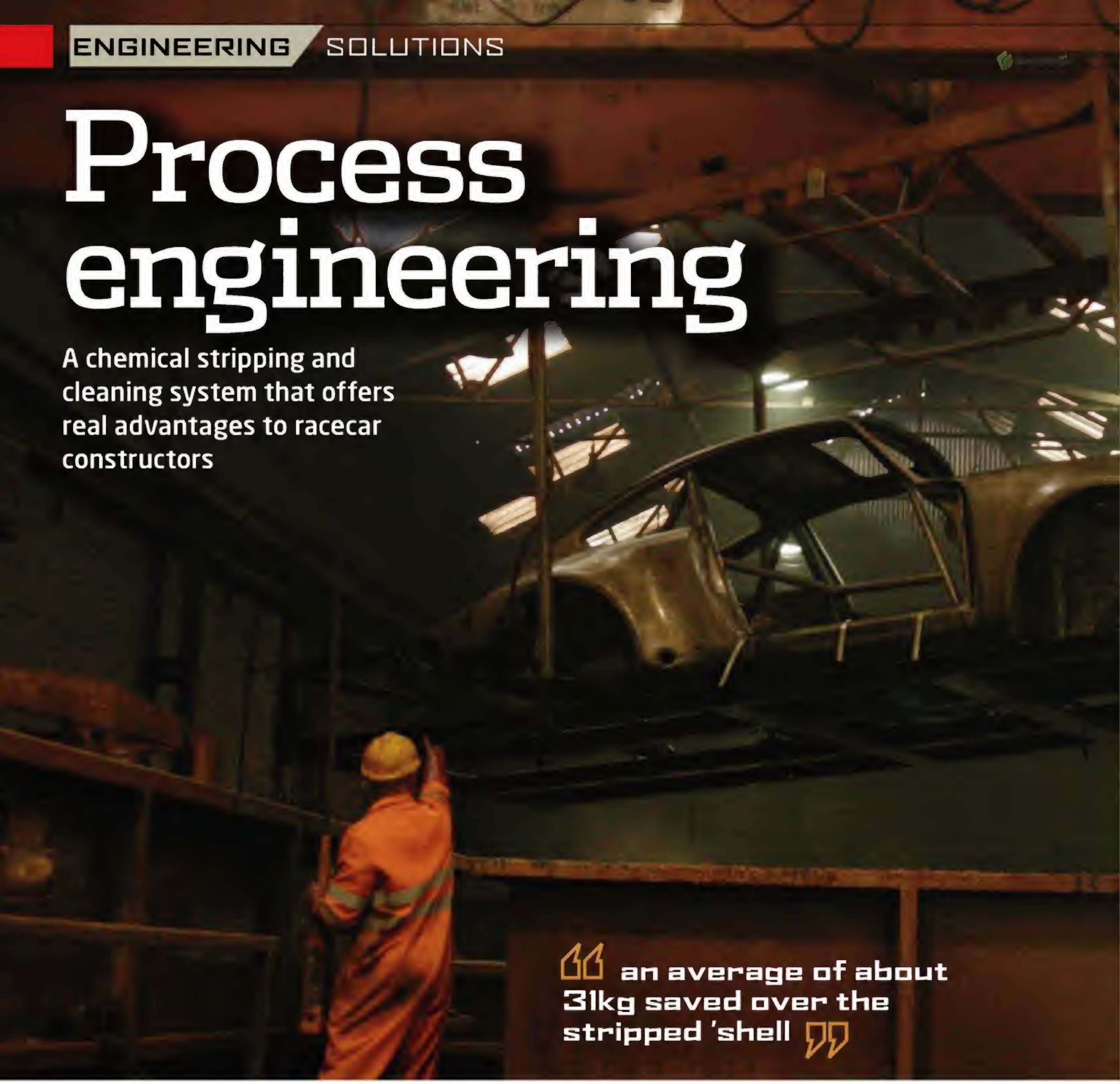
Dimensions:
Length: 4669mm
Width: 2000mm
Wheelbase: 2770mm
Track front: 1780mm
Track rear: 1760mm
Weight: 1200kg / 1100kg

Wheels:
Front: BBS/Braid 11 x 18in
Rear: BBS/Braid 11 x 18in

Tyres:
Front: Yokohama 265-650/18
Rear: Yokohama 280-710/18

Process engineering

A chemical stripping and cleaning system that offers real advantages to racecar constructors



> “an average of about 31kg saved over the stripped 'shell”

BY LAWRENCE BUTCHER

Back in the less stringently regulated days of Touring Car racing, a common trick to remove weight from a car was to acid dip the bodyshell. Unfortunately, the process had a number of flaws, not least the fact that acid residue tended to become trapped in box sections and continue to eat away at a vehicle's structure long after dipping. These days the process is all but extinct, primarily due to the exceptionally environmentally unfriendly nature of acid baths. Taking its place is a new technique, slowly gaining popularity amongst racecar constructors, which does not remove metal, yet is able to provide savings in terms of both preparation time and vehicle weight. Pioneered by Surface Processing company based in Birmingham, UK, this process ensures the removal of all organic material from a component without damaging the base metal. The majority of the work undertaken is for OEM manufacturers, stripping and re-coating products that fail quality control due to finishing flaws. However, the company has seen a steady increase in business from both the classic car and racing industries.

The benefits for the classic car market are immediately apparent: if a vehicle body is dipped, all accumulated rust, body filler and paint can be removed quickly and without the damage that can be caused by over-enthusiastic use of abrasive processes such as media blasting. But for racecar constructors, the advantages are more significant.

CORROSION PROTECTION

The process consists of multiple stages designed to strip all non-ferrous material away, leaving the remaining bodywork protected from corrosion. To achieve this, the vehicle is secured to a protective cage prior to being subject to a dehydration process to break down any organic coatings such as underseal, filler, anti-vibration materials and adhesives. The body is then immersed in an alkaline hydrocarbon solution to remove any remaining organic compounds. This penetrates box sections and other inaccessible areas, leaving the structure as bare mild steel, free of contaminants. Following this, the body is rinsed with water to remove the alkaline residue

As well as saving weight, bodyshells are washed with a preservative that protects the metal and can be welded through with impunity

before being immersed in a dilute solution of inhibited hydrochloric acid. The purpose of this is to remove any corrosion that may be present, with the inhibitor preventing the steel structure itself being attacked. From there, the 'shell is placed in an alkaline rinse prior to being dipped in an agitated alkaline solution, carefully formulated to ensure complete neutralisation of the metal. Lastly, it is subject to a high pressure manual wash with a preservative solution to protect the bare metal finish.

At this point, the 'shell can be taken away for welding or fabrication work, or can be subjected to a second process to coat and protect the bare metalwork, which culminates in the application of an electrophoretic coating. Firstly, the vehicle 'shell is subject to an eight-stage cleaning and phosphate treatment, consisting of decontamination through a number of alkaline silicate rinses before being dipped in a bath of phosphoric acid containing zinc, manganese and nickel. The body then moves to a PPG paint tank where it is immersed and an electrical current of 320v at 1000A is passed through it. This results in a uniform paint covering of 28μ thickness through a process of electrophoresis. Finally, the 'shell is cured at 180degC (356degF), providing a highly corrosion resistant finish, offering in excess of 1000hrs salt spray protection.

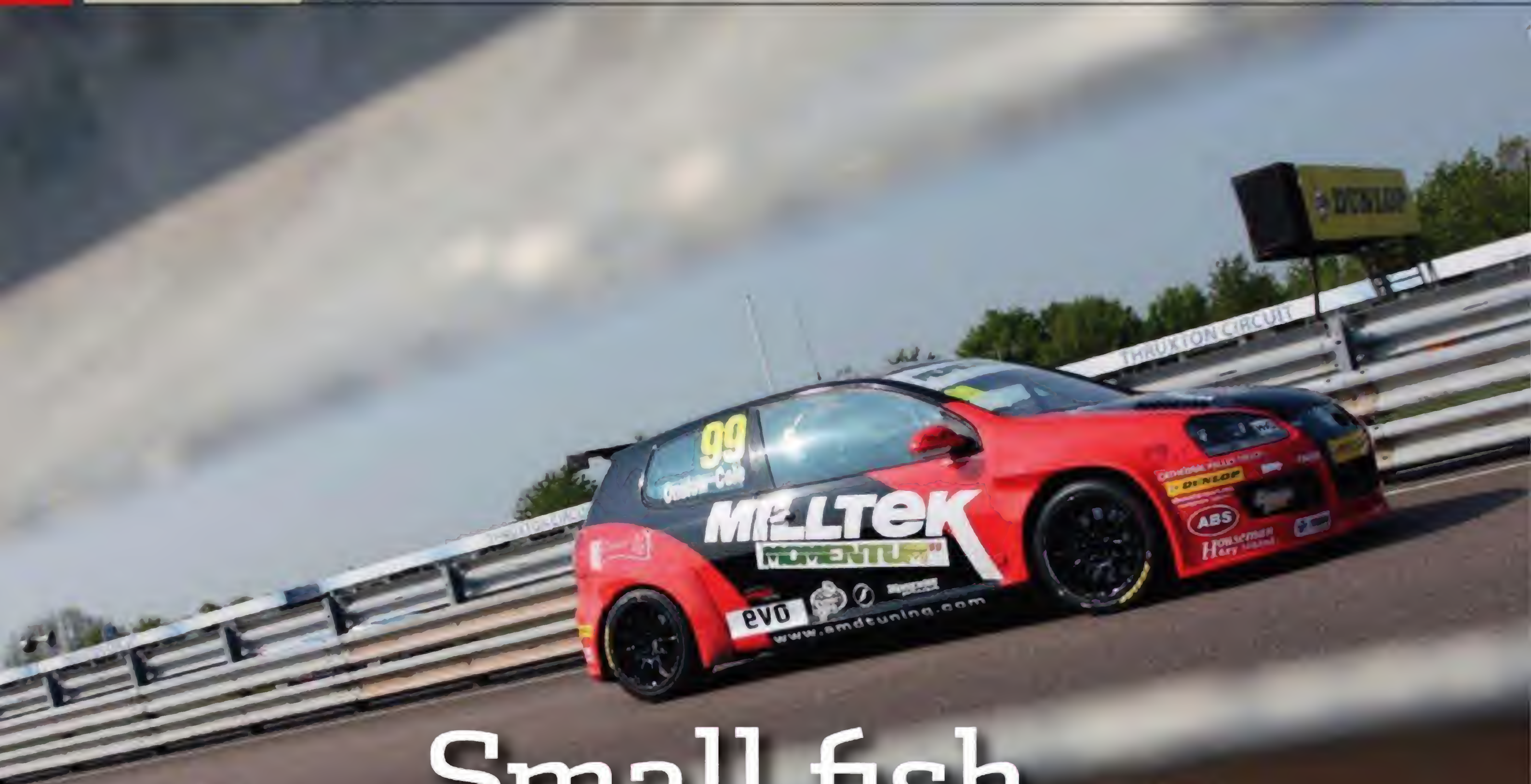
WELD INTEGRITY

And if you are thinking that welding a 'shell that has been chemically coated is not a good idea, Adrian McMurray, managing director of Surface Processing has an explanation: 'In a modern car plant they have all sorts of ways to prevent problems - they heat the area up first and then flush it with nitrogen so that it is clean and oxide free. [But] where traditionally a fabricator would have to spend a large amount of time cleaning up areas prior to welding, a vehicle that has been through the dipping process can be worked on immediately, with great weld integrity.'

While this offers considerable time (and therefore cost) savings, especially for constructors producing batches of cars, the real benefits can be seen in terms of weight savings. The 'shell of a modern production saloon, fresh from the production line, is an incredibly complex component. In some places panels can have up to five layers of material, including plastic and foam in-fills. And whereas with media blasting processes, only externally accessible material can be removed, it is in the removal of this hidden material that Surface Processing has found some very impressive weight savings. 'On a typical road-to-racecar project, it works out at an average of about 31kg saved over the stripped 'shell,' states McMurray, although apparently significantly greater savings have been seen on some high-end saloon bodyshells.

The racing world has taken notice and a number of top rally constructors and Touring Car teams have already called upon Surface Processing's facilities to give them an extra edge. At a cost of around £2000 ($3200) for the full process, the cost per kilo saved, combined with the reduced labour requirements, certainly makes it an attractive option.


AmD®
AmD Tuning
serious about tuning
Established 20 years
Tuning for Performance and Economy
Volkswagen
Audi
Seat
Skoda
Land Rover
Mercedes
Porsche
BMW & New Mini
Ford
Vauxhall/Opel
Home of the VW Golf in the British Touring Car Championship
BTCC AmD Milltek Racing.com
• 2/4wd rolling road*
• Power runs with Power Graph
• Special rates for clubs and Shoot Out days
• Workshop hourly rate £60+vat
• Set price menus
• Free fitting on Milltek Exhausts
• Coilover Fitting just £100+vat
• 4 Wheel Laser Alignment
• Air con servicing
• Servicing and diagnostics with OEM Parts
• MOT Testing
• Wi-Fi Internet and Playstation equipped Waiting Area*
• Courtesy shuttle service to Local Town Centre or Station
• Courtesy car available
* Depending on Branch
• Engine remapping for normally aspirated and turbo charged vehicles using world leading software tuners - AmD and REVO - from £299.95
• AmD Tuning Power Packs - include Remap, Milltek Exhaust and Pipercross Air Filter - from £499.95
• Uprated brake pads, discs and calipers for road and track
• Performance lowering springs, shock absorbers and coilovers from leading manufacturers
• Workshop, Servicing and Vehicle Diagnostics
50% OFF AmD Remaps...
...when we supply and fit a Milltek Exhaust System to your vehicle!!!!
To celebrate our partnership in BTCC we are offering an AmD remap at half price when we supply and fit a Milltek exhaust system to your vehicle
SAVE up to £400 on an AmD Remap & Milltek Exhaust Package Deal !!!!
These are just some of the money saving packages available:
Please call if your vehicle is not shown
Porsche 996 Turbo £2806 SAVE £400
Ford Focus RS MkII £939 SAVE £250
Vauxhall Astra VXR £670 SAVE £250
BMW M3 E92 £1239 SAVE £250
Mini Cooper S Turbo £785 SAVE £250
VW Golf MkIV GTi £537 SAVE £150
VW Golf MkV GTI £783 SAVE £250
VW Scirocco 2.0T £734 SAVE £250
Audi A5 3.0TDI £994 SAVE £250
Audi TT RS £1301 SAVE £350
Seat Leon Cupra £676 SAVE £250
Please call if your vehicle is not shown
MILLTEK SPORT
Milltek Exhausts - official fitting centres
revo
brembo
Pipercross
WEITEC
PRO-KIT
KW
Haldex
ap
mintex
AIRTEC
SCHRICK
SuperPro
EBC BRAKES
Special Offer!
Coilover Suspension Fitting - just £100 + VAT
includes laser 4 wheel alignment
www.amdtuning.com
AmD Essex
Next to Lakeside Shopping Centre and Ikea.
Close to M25 and Dartford Crossing
Unit 6, Cliffside Trade Park, Motherwell Way,
West Thurrock, Essex RM20 3LE
Telephone: +44 (0) 1708 861827
E-mail: sales@amdessex.com
AmD Kingston
Unit D Wellington Road,
New Malden
Surrey, KT3 3NE
Telephone: 0208 605 0695
E-mail: sales@amdkingston.com
AmD Kent
Coming Soon!
www.amdkent.com
TESCO
AmD Milltek Racing use* and recommend
MOMENTUM 99
Opening Times: Mon-Fri: 8.30am - 6.00pm. Sat: 9.00am - 4.00pm. Sun: Remapping/Club Rolling Road Shoot-Out days by appointment only
* Where allowed within regulations



Small fish... big pond

How a one-man band is making a splash in the British Touring Car Championship

The Volkswagen name has returned to the British Touring Car Championship for the first time since 1989, the final year that the championship was run with a multi-class format. The 2010 car is a Mk5 variant of the ubiquitous Golf, campaigned by another newcomer to the BTCC arena, AMD Racing, a privateer outfit based in the British county of Essex. The car and team have been one of the Touring Car success stories of the past two years, graduating from 'also rans' to regularly jostling established outfits for top 10 position.

BY LAWRENCE BUTCHER

Sean Hollamby, team principal, occasional driver, and proprietor of AMD, explains the path taken to the top flight of UK tin-top racing: 'We have run Seat Leons in the Dunlop Sport Maxx championship for the last few years, and won the championship in 2009. Before that, we ran Golfs in the VW Cup. Having won in Sport Maxx we looked at where to go next, and investigated a number of avenues - Britcar, Porsche Cup, all sorts of series. But we soon realised that it is not that much more to move up to the BTCC as a privateer, and that is a far bigger deal. It is very much an advertising, promotionally-structured project for us. It has got to get column inches, so even running towards the back of the grid, it is a thousand times better than winning in Britcar.'

AMD's car originally harks from Eastern Europe, Estonia to be precise. It had been campaigned in the FIA Baltic Touring Car series, against a similar variety of machinery to that found in the BTCC. The basic car is built around the VAG A5 platform, common to a number of Volkswagens, Audis and Seats, which provides a fully independent suspension chassis with an advanced multi-link rear end. This gives greater scope for chassis development than a number of similar vehicles in the compact sector, many of which still rely on a beam rear suspension set up.

For the 2010 season, the car debuted in essentially 'as bought' condition, though the chassis had been completely stripped and rebuilt. Time constraints did not allow for any major changes,

TECH SPEC

VW Golf BTCC

Chassis: VW Golf Mk5, based on the VAG A5 platform

Suspension: MacPherson strut front with multi-link rearValves: 32

Dampers: KW bump and rebound adjustable with remote reservoirs

Brakes: Alcon four-piston calipers with steel discs

Engine: NGTC-spec 2.0-litre turbocharged

Gearbox: Sadev six-speed sequential

ECU: Pectel

Data logging: MoTeC

Wheels: Team Dynamics

instead the available testing time being spent learning the existing set up. The chassis remained very similar to that of the road going car, retaining the standard suspension system and geometry, as well as components such as anti-roll bars. While these compromises limited the car's ultimate performance, it was a proven package in Estonia and had the pace required for the BTCC field. The team's first outings were not without incident - as is to be expected when starting the development of a completely new and relatively unknown package. However, it was immediately apparent that the Golf had the potential to be a competitive car, reinforcing Hollamby's opinion that a move to BTCC was the right call. 'Last year was hard work. Every circuit we went to was a new learning experience. We would start off a weekend around three seconds off the pace but, by the last race, this was normally down to about a second. Technically, it has been a steep learning curve, but also as a team boss looking after drivers, attracting sponsors, but I think we have come a long way.'

The AMD / Milltek Golf uses the new 2.0-litre turbocharged Next Generation Touring Car engine, but blanket boost restrictions to achieve parity with the naturally aspirated cars mean it's not yet running to its full potential

“The swap to forced induction has also seen an increase in reliability”

NGTC ENGINE

The biggest change for the team heading into the 2011 season was a move from the naturally aspirated Lehman / VW engine to the turbocharged NGTC (Next Generation Touring Car) powerplant. 'In our debut year our biggest problem was that we were always at the bottom of the speed traps. We knew the NGTC rules were coming and we were preparing for that. Now we have the turbo engine, it has jumped us up and we are now through the traps at the same speed the Fords were going last year. However, we have still not been quicker than the fastest naturally aspirated car. The blanket boost restrictions maybe need a bit of a review, and that is what is happening at the moment. If we hadn't adopted the new engine we would not have been racing this year, as with the lack of power it would not have been worth it.' The swap to forced induction has also seen an increase in reliability, thanks to the less stressed nature of the NGTC unit. After all, producing 300bhp from a turbocharged 2.0-litre is considerably easier than squeezing it out of a non-turbo unit. Despite being a completely different beast to the outgoing engine, fitting the new power unit was not as complex as one would expect. The engine's electronics are integrated with the existing wiring installation and the only major change is a move to a Pectel ECU. The increased power has improved the pace of the car considerably, with the low rpm torque delivery providing higher corner exit speeds. However, although the overall speed has increased, this does not provide the complete picture of the car's performance, as Hollamby explains: 'There is a lot more torque out of the corners. It is funny because in some corners we are no quicker

Above: custom bellhousing allowed the Sadev gearbox to be rotated slightly, improving driveshaft angles and allowing the car to run lower

Left: new multi-position, fabricated rear damper mounts allow the rear to be adjusted without compromising spring / damper functionality

This is the extent of the workshop operation - tidy, functional, but hardly what you'd expect from a competitive British Touring Car Championship team

than we were last year, but our lap times have improved drastically. The main reason for this is the lack of engine braking. It is a bit of a trickier animal on the brakes, so instead we are gaining the time down the straights.'

CHASSIS MODIFICATIONS

The chassis was also subject to extensive changes during the winter of 2010/'11, building on the experiences gained during the team's maiden season. Throughout 2010, the high ride height had compromised the handling, caused in part by excessive driveshaft angle limiting how low the car could be run. Conversely, if the chassis was run at its optimum height, driveshaft reliability suffered. To counter this, a bespoke bellhousing was produced to mate the Sadev six-speed gearbox to the new engine, the design of which allowed the whole transmission to be rotated counter clockwise, reducing the rake, and the consequent stress, on the driveshafts. This modification, combined with revisions to the subframe mounting, allows the car to sit lower at the front. In line with this, the rear suspension mountings were revised to allow a lower ride height and alterations to be made without unduly affecting the spring and damper rates. Where previously the chassis height was adjusted by changing the spring platform height, new top mountings mean the entire spring / damper unit can be moved up or down. In addition to these changes, the bodyshell was put on a major weight loss programme, which has allowed greater scope for re-distribution of ballast weight and lowered the c of g.

> **"cunning use of the cooling fans, rollers and a smoke wand gave the team an idea of the airflow"**

Despite the obvious limitations faced by being a privateer outfit, AMD still recognised that aerodynamic development was a valuable tool in garnering performance from the Golf, and this led to an imaginative use of the resources available to the team. Traditional straight-line testing was undertaken at the Bruntingthorpe testing ground, and this led to the rear wing being modified and given a wider adjustment range. A greater understanding of the interaction of the rear wing with the overall aero balance means that it can now be used to subtly alter the car's rear end behaviour.

But when it came to visualising airflow, lacking the funds for full-scale wind tunnel testing, some good old racer's ingenuity came to the fore. AMD's main business is tuning and re-mapping performance road cars and, to this end, they have an in-house 4WD rolling road. Through cunning use of the cooling fans, rollers and a smoke wand, the team was able to gain some idea of what the airflow was doing around the rear of the car. While admittedly not 100 per cent accurate, the information gleaned led them to modify the rear arches in an effort to reduce turbulence and drag.

SHREWD SELECTION

The AMD operation is by no means a large one, and all of the racing preparation is completed in workshop space shared by the main tuning business.

Shrewd selection of team personnel has helped the team develop. For example, team manager, Chris Tweed, has a wealth of experience to draw upon, having engineered cars in both the ALMS and FIA GT championship, as well as heading up VW Racing's Australian operation. Tweed's importance to the success of the project cannot be underestimated, and brings into sharp contrast the gulf between works and privateer teams. As Hollamby puts it, 'This is basically a racecar built in the corner of a workshop by one guy!'

The team's intention was always to treat entry into the BTCC as a three-year project, with the ultimate aim to be in regular contention for top 10 placing. Hollamby is pragmatic, and knew they would be hard pressed to compete with the front-running operations, but 2011 has seen the car take the fight to the established runners, managing on occasion to run with the front of the pack.

More importantly, by setting realistic performance targets and making the most of the limited resources available, the small, Essex-based team has proved that a privateer team can be competitive at the pinnacle of British saloon car racing.

It was this incident at Mid-Ohio in 2008 that prompted Honda Performance Development's safety programme

Fire extinguisher

Pit lane fires have always been a potential hazard in motorsport, but a new safety system from HPD aims to put a stop to this for good

BY ALAN LIS

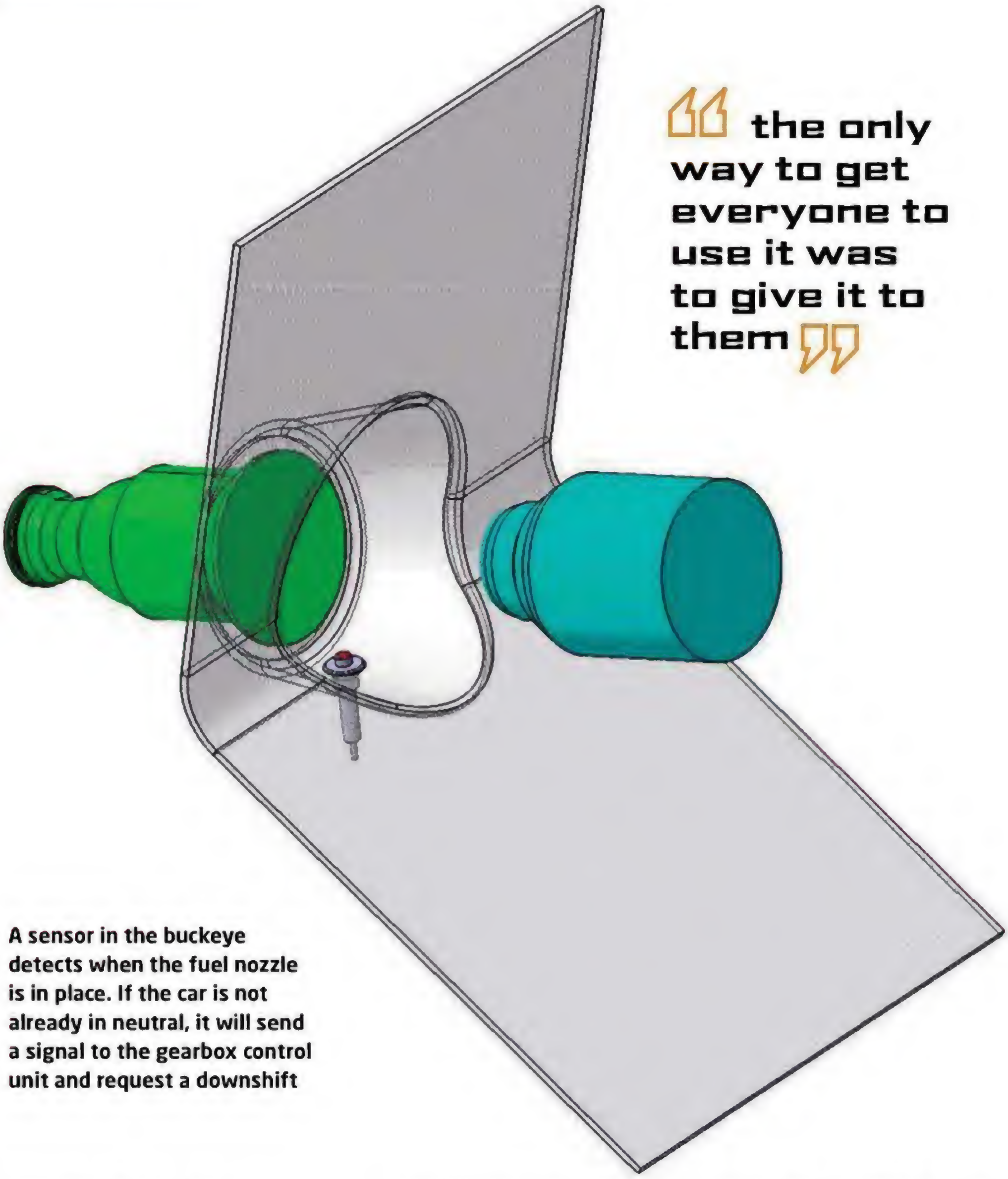
Pit lane fires are one of the great hazards in motorsport and, while every precaution is taken to prevent their occurrence, they are an accepted risk for race team crew members. However, at the opening round of the 2011 IZOD IndyCar series, every car was equipped with a new safety device aimed at changing this perception and preventing fires resulting from a driver leaving his pit before the fuel hose is detached.

The new device, developed and supplied by California-based Honda Performance Development (HPD), is the result of a programme that began following a pit fire at the Mid-Ohio round of the 2008 American Le Mans Series. Driver Simon Pagenaud received a signal to leave his pit, unaware that the hose connected to the pit fuel tank was still locked onto the inlet nozzle of his de Ferran Motorsports-run Acura (HPD) ARX-01 LMP2 racecar. As he moved away, the hose was torn from the pit tank, dousing the immediate area with several litres of high octane race fuel, which ignited. Prompt action by crew members and pit lane marshals soon extinguished the flames, but not before a crew member sustained serious burns to his hands and face.

HPD technical director, Roger Griffiths, was on the de Ferran Motorsports timing stand that day and recalls, 'My first thought was that we had to be able to do something so that a similar situation could not happen again.' So began the development of the HPD Refuelling Safety Interlock System (RSIS).

For ACO sportscar racing applications a solution was relatively simple, as the regulations governing the ALMS and other ACO series require the driver to switch off the engine before a car can be refuelled. Inhibiting the re-starting of the engine until the fuel hose is detached was therefore the answer. However, 'hot' refuelling is still a feature of many other forms of racing.

Although the ALMS incident provided the initial impetus for the RSIS project, HPD's focus soon turned to another racing category. 'When we sat down and thought about the problem, we soon came to the conclusion that there were actually many



> “the only way to get everyone to use it was to give it to them”

A sensor in the buckeye detects when the fuel nozzle is in place. If the car is not already in neutral, it will send a signal to the gearbox control unit and request a downshift

incidents with fuel spills in motor racing,' says Griffiths, 'and particularly in IndyCar racing.'

In the IndyCar series, the cars are refuelled with their engines running, so Griffiths' idea was not to allow the driver to engage first gear until the fuel hose has been disconnected.

With the HPD system, the racecar comes down the pit lane and the driver enters his pit box as normal. If he goes through the standard sequence of events ie puts the car into neutral and the refueller attaches the hose, the RSIS simply waits to see if anything happens. 'The whole thing about the system is that it is supposed to be effectively invisible to the driver,' explains Griffiths. 'If the car is still in first gear as the refuelling hose is connected, the sensor will send a command to the ECU requesting a down shift. The gearbox will then automatically shift into neutral.

'While the system detects that the gearbox is in neutral and registers that the fuel probe is in it masks any command by the driver via the up-shift panel to select first gear. The instant the probe is withdrawn the status changes and the GCU is then able to react to a command from the up-shift panel, meaning the driver can then select first gear and drive off.'

SYSTEM CHECKS

The system also makes a number of other checks, such as determining that car speed is zero and that the pit lane speed limiter has been activated. These checks are done so that the system cannot be inadvertently activated while the car is running at speed on the track. The system is also able to cater for other scenarios, such as when an IndyCar leaves its pit box after refuelling and a crew member squirts a jet of water at the fuel 'buckeye' to make sure that any residual ethanol fuel is diluted in order that it cannot ignite.

'What we don't want is for the sensor to react to the water,' continues Griffiths. 'If there is any kind of foreign matter, such as tyre rubber, debris from an accident or water, the sensor will register its presence as it can't distinguish the difference. But to ensure the system is not inadvertently triggered in such a scenario there is an automatically activated mask that kicks in for a number of seconds as the car leaves the pit box. Then, once the car gets above a certain road speed, the system is also masked so that it cannot then be triggered by a piece of debris landing in the buckeye while the car is running on the track.'

The RSIS can also check if there is an error from the sensor, if it has failed or if something else has gone wrong and will, via telemetry, send a warning to the timing stand. 'In that situation the gearbox can be put into emergency mode,' says Griffiths. 'We've deliberately made the system very easy to override. Of course that means that a driver could do that when he comes into the pits, but any car that is in emergency mode and is overriding the system shows up immediately on our telemetry. We have an agreement with IndyCar that we will monitor that and, if we see something suspicious, we will report it. At the beginning of the season the drivers were told that any indiscretion in that regard would result in a drive-through penalty.'

MANDATORY FROM 2011

Following successful tests, the RSIS was made mandatory from the opening round of the 2011 IndyCar series - a process made possible by HPD's commitment to supply the teams with one free system for each car running in the series. 'That's a cost of $800 (£490) per car, but we realised that the only way to get everyone to use it was to give it to them,' observes Griffiths.

To date the reaction to the RSIS has ranged from neutral to positive. 'In the races so far there have been no obvious issues with the system,' concludes Griffiths. 'We've had no negative feedback from the teams and the drivers I've spoken to about it say it doesn't make any real difference to them.

'The only time extension to a pit stop is in how long it takes the driver to react. All teams have put an indicator light on the dashboard of their cars to show when the fuel probe is in. Now, during a pit stop the driver just stares at the light and, as soon as it goes out, they select first gear and go. The difference between a pit stop with the system and one without it is probably half a second, maybe less. In fact, one of the drivers told me that it may even have made pit stops faster because he selects first gear and goes as soon as the light goes out. I was slightly alarmed at this and said, "You still need to watch your crew man that's guiding you out! Collision avoidance isn't a part of the system!"'

Formula Student 2011

Bespoke ECUs, international collaborations, beam axles and homemade differentials, this year's events threw up some genuine, and welcome, surprises

BY GEMMA HATTON

For the fourth year running, Germany triumphed at in the Formula Student competition, held at Silverstone, with Rennteam Uni Stuttgart taking the overall Class 1 win. On top of that, the team collected five more awards and consistently scored above 70 per cent across the board, with Presentation and Design scoring in the high 90s.

Consequently, Stuttgart was a strong contender going into the tough Endurance event, which is renowned for being a car breaker. The amount of full throttle running on the new Silverstone track resulted in a number of engine failures and a staggering 45 per cent of cars not finishing, including several front-running teams such as Global Formula Racing (GFR, a collaborative effort between DHBW Ravensburg, Germany and Beaver Racing from Oregon State, USA), overall event leaders, Bath, and the Oxford Brookes University team.

England's fickle weather played a crucial part in the dynamic events and Stuttgart managed to put in a luckily-timed dry Endurance run, which topped the tables, and the torrential showers that followed meant its rivals could not even come close.

In second place was last year's winner, TU Munich, while UH Racing (Hertfordshire) scored an impressive third place, making it the top UK team once again.

Stuttgart's design philosophy was 'to put several thoughts on maintainability and accessibility at the rear of the car.' It decided on a modular concept, with a composite monocoque at the front and a tubular spaceframe at the rear, enabling easy access to the engine components. That saved time in testing, and allowed them instead to concentrate on preparing the car for the competition.

> **"Weight is a major factor when designing a successful Formula Student car"**
>
> **John Hilton, chair of Formula Student**

Consequently, the team finished the car at the end of April, and went testing 'twice or three times a week', as well as taking advantage of a 'pre-event', organised by main sponsor, ZF, where all teams sponsored by the company were able to simulate the Endurance and Sprint events.

With electronic systems highly evident across the 2011 field, Stuttgart claimed to have a basic car, with a philosophy that, 'if you do too much in electronics, you could get more problems. We do a lot, but only what we need, so there are no special extra features.' However, the team did later reveal that the car was equipped with a cone light which illuminated when the driver hit a cone and picked up a penalty 'just so he knows he did something wrong,' revealed the team.

With the weather so changeable at Silverstone, the ever-present debate over aerodynamics continued, with the controversial GFR car dominating the Sprint event and proving to be by far the fastest car in the wet during the Endurance event. The joint team's design had all

The neat, tidy design of the Stuttgart entry used a tubular rear frame and a composite monocoque front, with the emphasis on ease of maintenance

The winning car from Rennteam Uni Stuttgart, *en route* to taking overall first position in the UK Class 1 competition - one of the few cars to get a dry run in the all-important Endurance event

the garages talking as not only was it the only car at the event with large wings, in common with just a handful of other cars it was also fitted with a downforce-generating under body. 'Aero in the US is much more common. Events in Los Angeles have six or seven cars with aero,' explained an Oregon State team member. 'Most of the time in the Sprint event the top three cars have wings, and we were tired of being the fourth team. Using CFD and lap time simulation, we realised that aero was the most significant thing we could do to improve lap times.'

Weight is a major factor when designing a successful Formula Student car, as John Hilton, chair of Formula Student, says: 'I believe that light cars go well at this competition.' Weight is even more critical, however, when optimising performance with aero. 'The lighter the car, the more effective it is. Per weight, whatever downforce we get helps us more than a heavier car.'

The average weight for Class 1 entrants this year was 218kg, but with the GFR car weighing in at just 156kg and its extravagant aero a mere 22kg, a few more eyebrows were raised. Carbon fibre had a big part to play and was used in the manufacture of the monocoque, wings and panels. In fact, the only steel part was a tube within the nose of the car that was required by the rules.

DOUBLE THE CHALLENGE

This may all sound expensive, but the fact that GFR was a collaboration between two teams meant it had double the funding and double the number of students (100 in total), which perhaps explains why it went for double the challenge of using aero. But aside from sheer numbers, building a successful car between teams that are some 8742km apart brought its own challenges, and the results proved an inspiring achievement. 'It was a huge challenge,' enthused one team member, 'How do we make sure a part made in the US is going to be able to bolt up to a part made in Germany? It was something our advisor pushed for to educate us so we had that experience when we go out in the real world. And the response from industry has been great.'

Overall, their combined hard work paid off, but issues with the car saw it fail to finish the Endurance event. Nevertheless, theirs was the highest-placed team with a non-finish at Endurance next to their name, 15th position overall.

Another team to use aero was last year's winners, Munich, albeit in a more subtle way than GFR. This was a result of rule changes that allowed more flexibility in aerodynamics, so creating 2D profiles and testing them with CFD, the team began to develop wings and an under body in carbon fibre. Of course, this saw the car gain some weight but, according to the student who led the aerodynamic project, 'all of the weight that was put onto the car with the under body and the wing was saved with the other parts of the chassis.' In fact, the design was so intriguing that the team's main sponsor, Audi, offered the use of its wind tunnel to validate its CFD programme. Unfortunately, time restrictions prevented that from happening. Of particular interest, though, were the ducts that aimed at the tyres. 'It's because the rotating masses produce a lot of drag, so we tried to bring the air to flow around the tyres, like a front wing.'

Contradictions are a common occurrence in motorsport, and no more so than in Formula SAE events, so it's no surprise to hear that some teams disagree with the use of 'heavy' aerodynamics. Such is the case with the University of Bologna, Italy, for

TECH SPEC

Class: Formula SAE

Weight: 190kg

Chassis: two-piece hybrid with carbon monocoque and tubular spaceframe rear

Engine: 2004 Honda CBR 600-RR, 67mm bore, 42.5mm sroke, four cylinder, 599cc

Electrics: lithium ion battery, Bosch MS14

Fuel system: sequential fuel injection

Performance: maximum power at 11,000rpm / maximum torque at 8000rpm

Transmission: Drexler limited slip differential, TBR adjustable, single 520 chain, final drive: 3.5:1

Suspension: double unequal length A-arm, pull rod / push rod-actuated ZF Sachs dampers, T-ARB / U-ARB

Brakes: radial mounted ISR caliper, floating disc 240mm / 200 mm

Wheels: OZ Superleggera 7 x 13

Tyres: Hoosier 20.5 x 7.0-13 / 20 x 7.5-13

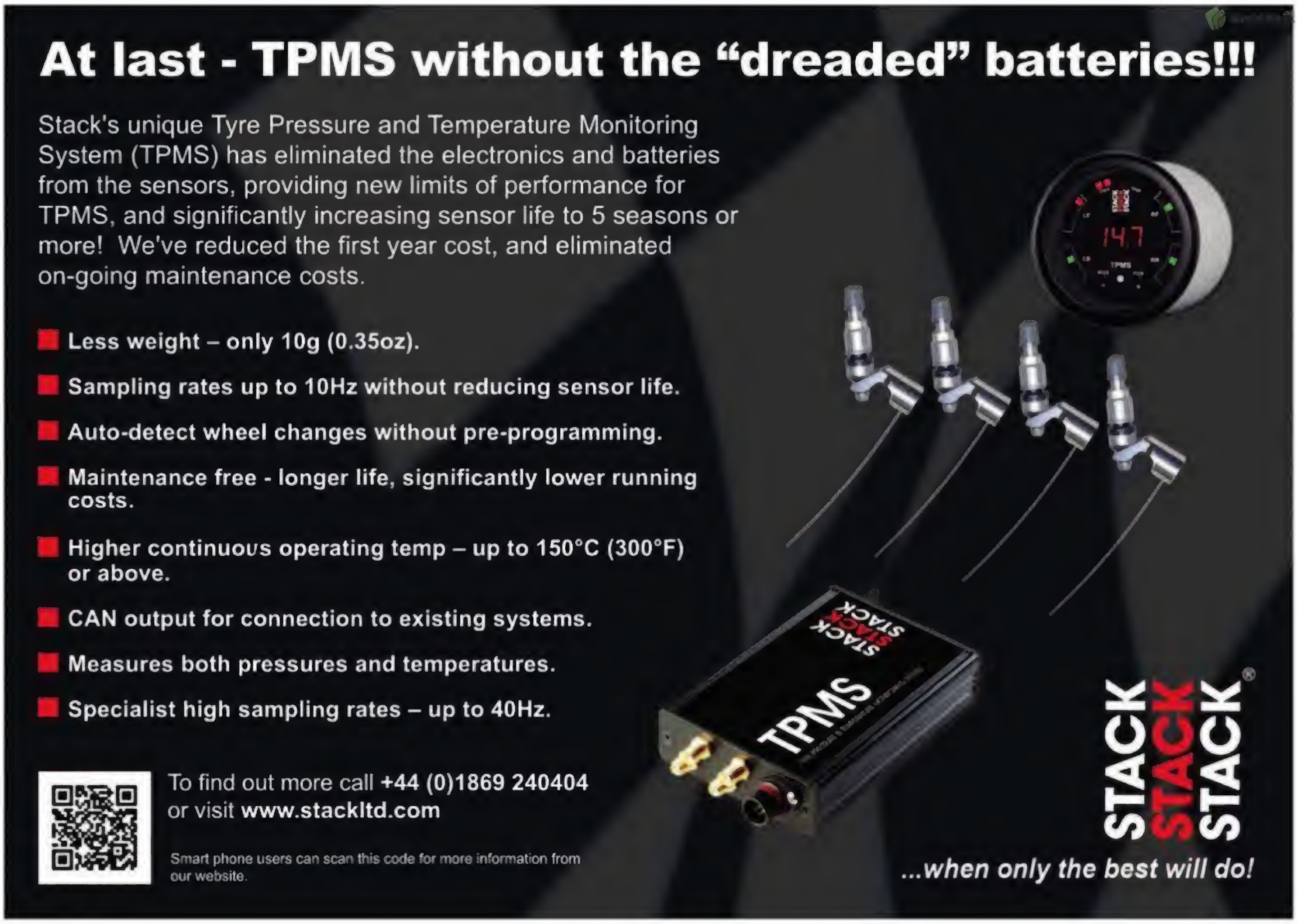
Length: 2678mm

Width: 1405mm

Height: 1070mm

Track: 1210mm front, 1175mm rear

Fuel: E85 / 99Ron


At last - TPMS without the "dreaded" batteries!!!
Stack's unique Tyre Pressure and Temperature Monitoring System (TPMS) has eliminated the electronics and batteries from the sensors, providing new limits of performance for TPMS, and significantly increasing sensor life to 5 seasons or more! We've reduced the first year cost, and eliminated on-going maintenance costs.
Less weight – only 10g (0.35oz).
Sampling rates up to 10Hz without reducing sensor life.
Auto-detect wheel changes without pre-programming.
Maintenance free - longer life, significantly lower running costs.
Higher continuous operating temp – up to 150°C (300°F) or above.
CAN output for connection to existing systems.
Measures both pressures and temperatures.
Specialist high sampling rates – up to 40Hz.
To find out more call +44 (0)1869 240404
or visit www.stackltd.com
Smart phone users can scan this code for more information from our website.
TPMS
STACK STACK STACK
...when only the best will do!


Castroper Strasse 80 • 44628 Herne • Germany • Phone: +49-2323/18429
www.tennant-metall.de • e-mail: post@tennant-metall.de • Fax: +49-2323/18427
TENNANT
Metall & Technologie GmbH
Your Contact for Engineering & Aircraft Metals
We are a EN 9100 certified stockist of materials for F1/WRC/DTM applications and have been supplying various special steel grades and forms to international customers for more than 20 years. Our steel grades are designed for highest stress applications and are used for the manufacture of roll cages, motorcycle and bicycle frames, wishbones, spaceframes and axle parts.
Our strength:
• competent advice
• supply of small quantities
• cutting to size
STEEL COMPETENCE
Special Steels in Material Grades 25CrMo4 and 15 CDV6 / 1.7734
available ex stock Herne in the following forms:
• Tube - round, oval, aeroprofile (teardrop), rectangular, square
• Bars • Flats • Sheets
We also supply Welding Wire in appropriate grades.
All material accompanied by test certificates.
We can cut to size and arrange transport at competitive prices.

Convinced by CFD and lap time simulation work of its benefits, the GFR entry also had this downforce-generating underbody

One of the few teams to fully exploit the potential benefits of aerodynamics, GFR turned up with an elaborate front and rear wing set up

example, whose team leader argued that 'we think at our speed aerodynamics are useless, so we didn't do any studies into downforce generation.' Instead, the team chose to focus on electronics: 'We have a complete self-made electronic control unit, which we programmed by ourselves. It's been hard work but the results are very interesting because we can change everything.'

With so many varied methods, attitudes and design philosophies on show, there seems to be no one technique to achieving the fastest car. However, experience is essential, and one man who has plenty is Formula Student patron, Ross Brawn.

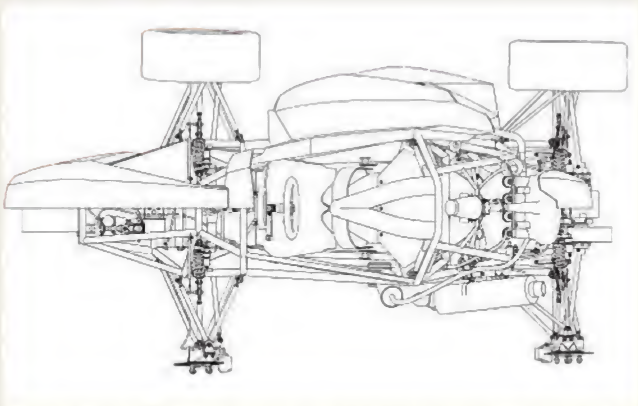
He believes that to make a successful Formula Student car 'you need to understand the regulations thoroughly. You need to know what it is you're trying to achieve, and then understand the resources you have available in terms of setting the engineering tasks. It's no good designing a fantastically complex engineering solution if you don't have the resources... in terms of performance, getting weight down is one of the strongest factors you can apply to the performance of the vehicle, but obviously doing that without compromise is the key.

CAR FOCUS - CTU CARTECH FS.03

CTU CarTech from the Czech Technical University in Prague entered the competition for the third year in 2011, running its brand new car, FS.03.

'On the previous car we had some problems with understeer, oversteer and suspension geometry, so this year we aimed to have a better suspension. We also wanted stiff parts, so we re-designed the uprights. On the rear suspension we lowered the weight with the integration of the rear driveshafts into the wheel hubs, which are made from chromium steel and have about 50 Rockwell hardness. We also bought better dampers, which weigh 700g including springs. This is a big difference to our previous car, where the dampers weighed about 1.7kg. So by changing just one part, we saved 4kg.'

The car's interesting design was based around things found in nature and developed using Autodesk software, while the engine is a 2009 Yamaha YZF-R6, to which the team added a new air box, cooling system and exhaust. 'From our experience in Germany, where the track was quite technical, we tried to have maximum torque and power in lower engine revolutions, about 9,000 or 10,000rpm. Therefore, we have longer pipes on the air box and exhaust, which gives us better acceleration through corners.' The car body weighs about 8kg and is made from carbon fibre.



Most of the development work in the CTU FS.03 went into improving the suspension, using Autodesk software to draw up the new designs

At the start of the event, the team admitted it was nervous about the forecasted wet weather: 'We tested only one week and raced about 170km in dry conditions, so the wet will be a little tricky.' A little tricky it may have been, but the hard work paid off and the team achieved an incredible top 10 finish, which was a vast improvement on last year's 35th.

ADFA SUSPENSION

One feature that caught the attention of many was the suspension design on the Australian Defence Force Academy at the University of South Wales (ADFA) car in Australia. 'We've got a pretty unique suspension design with a beam axle at the front and the rear. The rear is a De Dion twist axle, so we've put a slot down the centre of the beam so that it's kinematically compliant and can roll. We've also got a Watt's linkage in the back, so it's a really different concept to what other teams have,' explained the team leader who came up with the concept.

The benefits were already evident. 'The beam axle system cuts the number of chassis hard points by 60 or 70 per cent. On the front we've only got four pick-up points, whereas on the independent suspension car we've got eight just for the wishbones. When you start including the rocker and the damper, that gets even more. What it allowed us to do was to build the chassis with the minimum amount of jigs, so the manufacturing was quicker and easier. We also got rid of 16 spherical bearings on the car, again reducing costs. The whole idea is to give good wheel attitude control. Of course, there are compromises, like unsprung mass, but we can actually touch our roll centre. It's a physical thing, which makes it easier to tune the car.'

This brave design choice was a result of the team being very resource constrained. 'We had to design it using the top level systems engineering approach - looking at what aggregation of sub-optimum systems is going to give the best system for the team. The university were looking at cancelling the entry, because previously we were finishing the car three days before the competition. It was unreliable, heavy, overpriced and sapped all the resources. So these circumstances were what drove the design.'

The proof came in the overall results, as ADFA Racing finished seventh in Australia having finished third in Acceleration and Fuel Economy. From that point, they decided to go further afield. 'We thought while we've got something pretty different, why not take it overseas and see what everyone thinks?' They finished in the top 20 on the Skidpad and the Design final at Silverstone.

A radical re-think of the use of resources led to the inclusion of a De Dion beam rear axle, greatly simplifying the rear suspension assembly and making manufacture quicker, easier and cheaper. It worked, too

Formula SAE

BY KALEY ZUNDEL

FSAE CALIFORNIA

With wins in Design, Acceleration, Endurance and Overall Dynamics and a 94.5 point lead over the second place finishers, École de Technologie Supérieure (ETS) clinched first place overall for the first time in the university's history, in the process making it the first Canadian university to win the North American Formula SAE series.

The 2011 competition was held at the Auto Club Speedway in Fontana, California for the sixth and final year and welcomed its highest attendance yet, with 61 teams registering. They represented Brazil, Canada, China, Japan, Mexico, UK, USA and Venezuela. All static events took place in the NASCAR garages and suites, while the dynamic events were staged and run on the infield course areas.

Taking first place in Cost was the University of Alberta entry with an adjusted cost of $10,027 (£6120). That was just $578 (£353) higher than the team's 2010 budget, which also captured it a first place finish. Alberta also won first place in Presentation.

Announced for the Design semi-finals were seven universities: University of Oklahoma; University of Washington; Oregon State University; Missouri University of Science and Technology; University of Bath; École de Technologie Supérieure and University of Wisconsin-Madison.

Out of these seven semi-finalists, Oregon, Bath and ETS went forward to the Design finals and public review, where the performance on track and the knowledge of the students were thoroughly assessed. Design event captain, Mike O'Neil, eventually pronounced ETS the overall winner.

The Dynamic events started with morning Acceleration and Skid Pad sessions, followed by the Autocross event in the afternoon. With 43 cars crossing the start line in Acceleration, it was ETS who crossed the finish line with the shortest elapsed time of just 3.916 seconds.

Of the 41 cars that entered the Skid Pad event, the University of Oklahoma posted the best time of 4.878 seconds to take first place, while in the afternoon, 47 cars crossed the starting line for Autocross. And with a wing designed on the car for the first time in the university's history, Oregon State University's entry seized first

With wins in four separate categories and an astonishing 94.5 point lead, the École de Technologie Supérieure (ETS) was dominant


We're driven by performance.
And what drives you?

2010 saw the first international collaboration build an entire FSAE car, and GFR followed up its good work this year by winning the event for a second year running

BOLOGNA

As well as mechanical and automotive engineers, Formula Student also presents challenges to electrical engineers, and the increase in the standard of the electronics systems seen on the 2011 entries was phenomenal. Almost every car on the grid had some type of updated or modified ECU and data loggers to monitor everything from tyre temperatures to water coolant pressures. The team from Bologna, Italy had a particularly interesting design, which was entirely self-made. 'It has been a challenge, even with our two professors from the University,' said a team representative. 'We used National Instrument hardware and the same company's Labview software for the control of the engine bench. We programmed everything - the FPGA and the real time. The results are very interesting because we can change everything with only our ECU, compared to other teams that have two or three control devices. This year we also introduced electric actuation of the gear change. We can even control the engine in real time, which allows freedom of use,' enthuses one of the students.

This advance technology comes at a price, but not if you are the first team to do it. 'In the first year, National Instrument lent us the ECU but, seeing the interesting results at the end of 2010, they gave it to us for free. If you have a commercial ECU you cannot change the softness of the ECU, but we can, so it's possible to really do everything.'

Building a bespoke electronics system for a competition car is a major achievement, but the students from University Bologna, Italy went one better and even programmed their own ECU

place with the fastest time of 61.463 seconds, just seconds faster than both second and third place finishers and long-time advocators of wings, University of Kansas and Maryland.

Saturday's Endurance and Fuel Economy events concluded the competition just prior to the award ceremony. Fifty two cars took the green flag in Endurance but only 30 cars received the chequered flag and of those, two were outside the maximum permitted time limit. Once again, ETS finished the event first with the fastest time of 1345.438 seconds, having hit a total of three cones. The University of Maryland entry was a close second with a time of 1352.107 seconds and two cones, and in third place was University of Wisconsin-Madison with a time of 1369.156 seconds, also with two cone penalties.

Capturing first place in Fuel Economy for the second year running was University of California, Irvine, who last year showed up with a car containing a Briggs and Stratton engine primarily built for fuel economy.

The award ceremony wrapped up the day with École De Technologie Supérieure being announced as first place overall, University of Oklahoma taking the second place slot and University of Wisconsin-Madison third.

The 2011 competition ended with the announcement that the 2012 Formula SAE competitions will be located in Brooklyn, Michigan and Lincoln, Nebraska.

FSAE MICHIGAN

Joining the ranks with only two other teams (University of Texas-Arlington and Cornell University) to pull off a back-to-back first place finish in the history of Formula SAE, Global Formula Racing (GFR) - an international team collaboration consisting of students from Oregon State University and Duale Hochschule Baden-Württemberg-Ravensburg of Germany - clinched that honour when it was named first place finisher at Saturday night's award ceremony in MIchigan.

To take the overall title, GFR obtained first place in three of the most highly sought after categories, including Engineering Design (sponsored by PTC), Endurance and SAE Spirit of Excellence. Along with those first place finishes, GFR captured eight more awards in various other events.

The collaboration started with students designing aspects of each other's vehicles, but moved to a whole new level last year with the two universities working together as one to design and build an entire car to enter both in the US and EU competitions.

Formula SAE Michigan's competition returned to the Michigan International Speedway in Brooklyn for its fourth year, making use of recent updates to the site, including the construction of suites, which were used for the Presentation category. All the dynamic events were held on the back side of the oval, which will be re-paved for next year's competition.

Over 100 teams registered for the competition, with 99 bringing working vehicles to the event, representing colleges and universities from Austria, Brazil, Canada, Germany, India, Mexico, Singapore, South Korea, UK, USA and Venezuela.

Technical inspection approved all 99 cars, but not all passed through the subsequent fuel / tilt and brake / noise tests. After a full day of Design judging, 13

OXFORD BROOKES

Formula Student teams consistently bring new developments, ideas and technologies to the circuit and one of the usual suspects is Oxford Brookes Racing, whose car came to the 2011 event with an innovative aluminium chassis. 'We went back to basics and pre-cut every skin,' explained a team representative. 'The outside skin, inside skin and the core itself are all processed separately, which meant we could add the hard points into the core at the bonding face and create a much lighter assembly. We increased our chassis stiffness by about 100Nm per degree, which is massive for us to do.

'The other overall concept we've gone for is trying to pull every component that used to be tucked away to the surface.' Not only does this make the components easier to access, but also reduces repair time during testing, and testing is essential to iron out all the minor errors, increasing the reliability of the car prior to the main competition.

To decrease weight further, the team went for a minimalist approach: 'If it doesn't need to be there, then it isn't.' For instance, there was only one sidepod, on the left-hand side of the car. 'There isn't a replica component on the other side, purely because what would it actually do if it was there? If it can't make the car faster, or pass a certain rule, it shouldn't be there.' This attitude contributed to a fourth place finish in the Design section of the competition.

Vignesh Viswanath

Use of an aluminium chassis with pre-cut panels and bonded-in hard points contributed to a significantly lighter and stiffer design

With firsts in Engineering Design, Endurance and Spirit of Excellence categories, Global Formula Racing took a convincing win in Michigan

Graz University of Technology from Austria took first in Skid Pad, and came in a creditable third in the Endurance category

teams were invited to participate in the Design semi-finals: Oregon State University; Graz University of Technology; Universitat of Stuttgart; Technical University of Munich; Rochester Institute of Technology; University of Applied Sciences - Graz; University of Michigan - Ann Arbor; University of Wisconsin - Madison; Cornell University; Karlsruhe Institute of Technology; University of Applied Sciences Amberg-Weiden; University of Applied Sciences Zwickau; Universidad Simon Bolivar and Virginia Tech. Pushing forward into the Design finals were: Oregon State University; Graz University of Technology; Universitat of Stuttgart; Rochester Institute of Technology; Technical University of Munich and University of Applied Sciences Graz.

Taking first place in Cost was Kookmin University from South Korea, while receiving first place honours in the Presentation event was Universitat Stuttgart from Germany.

Those cars that passed technical inspection went on to compete in the Skid Pad and Acceleration runs, and with unseasonably high temperatures for Michigan, Cornell University added some heat with a first place finish in Acceleration, clocking a time of 3.945 seconds. Heating up the pavement even more was the University of Applied Sciences - Graz from Austria, who won the Skid Pad event with a fastest time of 5.154 seconds.

In the afternoon, teams completed their runs for the Ford Autocross - this year designed with assistance from the Sports Car Club of America (SCCA). Eighty four cars crossed the starting line, and finishing in first place with a clean run and fastest time of 48.151 seconds was University of Kansas-Lawrence, a whole 15.3 seconds faster than the 2010 winner in this category.

Clinching second place was Oregon State University (GFR) with a fastest time of 48.535 seconds, while in third place was South Dakota School of Mines and Technology with a 48.577-second run. Teams who completed the event and placed were assigned a position in the Endurance run order, and to increase the excitement, SAE International decided to invert the running order from slowest to fastest cars. As with every change, there is some trial and error and the organisers accepted there may have been some flaw to this running order concept, but ensured all competitors that the issue will be resolved next year.

Of the 86 cars that started the course, only 35 finished, with GFR placing first with an adjusted time of 1502.288 seconds over 28 laps, having hit seven cones. Coming in second with an adjusted time of 1517.286 and six cones was Technical University of Munich, while in third place was Graz University of Technology with an adjusted time of 1521.930 due to clipping five cones.


VARLEY RED TOP™
The Motorsports Battery
Congratulations to the University of Hertfordshire Formula Student team
The Varley Red Top team at DMS technologies congratulates the UH Formula Student team for their excellent performance in coming 3rd overall in Class 1 at Formula Student UK this year.
DMS technologies
Belbins Bus. Pk, Cupernham Lane, Romsey, Hants SO51 7JF, UK
tel: 01794 525400 e-mail: sales@dmstech.co.uk
www.varleyredtop.com


2002
2003
2004
2006
L.M.C.
Manufacturers of the finest Permenant Magnet DC motors in the world.
L.M.C. Ltd
Unit 8 Park Court
Heathpark Ind. Est.
Honiton
Devon
EX14 1SW
UK
Tel+44 (0)1404 549940
sales@lmcltd.net
www.lmcltd.net
LYNCH MOTOR COMPANY


Heavy-duty
spherical bearings and rod ends for motorsport
Certified as per EN 9100!
The art of performance
Driven by quality
Power – Precision – Passion
Smart way of moving
HIRSCHMANN
HIRSCHMANN GMBH · D-78737 Fluorn-Winzeln
Phone: +49 (0) 74 02/1 83-0 · Fax: +49 (0) 74 02/1 83-10
www.hirschmanngmbh.com · info@hirschmanngmbh.com


AEROCOM
METALS LIMITED
ADVANCED MATERIALS FOR HIGH PERFORMANCE APPLICATIONS...
Titanium Alloys
Special Steels
Nickel Alloys
Stainless Steels
Aluminium
Hastalloy
Waspaloy
Inconel
SALES 02476 645 551
www.aerocommetals.co.uk

Alternative fuels

Formula Hybrid, and Formula Student Class 1A

This year's sixth annual Formula Hybrid International Competition was run over three days at New Hampshire Motor Speedway, USA. The event was won convincingly by the team from Texas A&M University, who were the victors in two of the four segments of the competition. Led by team advisor, Dr Make McDermott, the Texas A&M team won both the Acceleration and Autocross contests, scoring a total of 871.2 points. Texas A&M's car is called 'Medusa' and is powered by a combination of a 32bhp Yamaha YZ250F petrol engine and a 40bhp brushless DC electric motor, assisted by a li-polymer accumulator. The car weighs only 620lb (280kg).

Second place was taken by Brigham Young University's 'Blue Fury', led by team advisor, Dr Robert Todd. Brigham Young's team won the Presentation and Endurance segments of the competition, totalling 712 points. Blue Fury is powered by a 24bhp Yamaha WR250R petrol engine and a 40bhp Oxford YASA electric motor with a 259V lithium-polymer accumulator.

Third overall, and winner of the Design segment of the contest, was Sweden's Lund University, led by team advisor Stefan Skoog. Lund's car is powered by a Honda CBR250 petrol engine, assisted by a 25kw, three-phase, low-voltage electric motor and Thundersky LFP40 accumulator. Lund's team and car totalled 691.6 points.

The top six in this year's Formula Hybrid competition, in descending order, were completed by University of California Davis, Dartmouth College and Canada's McGill University. In total, 34 teams from universities around the world entered this year's competition, presented by the Thayer School of Engineering at Dartmouth, the Society of Automotive Engineers International and the IEEE, the world's largest association of engineers. Primary sponsors of this year's competition were were Chrysler, Ford, General Motors, Toyota, IEEE and the New England Region of the SCCA.

TECH SPEC

Class: FSAE - Formula Hybrid

Drive: rear

Engine: Yamaha YZ250F

Power: 32bhp

Generator: none

Drive motor: student-developed brushless direct current, 40bhp

Accumulator: lithium-polymer battery pack

Tyres: Hoosier slicks

Coatings: Polydyn

Cal Poly's 'camber car' will look strangely familiar to long-term readers of Racecar Engineering...

Very fast overall in Sprint and only hampered in the Endurance by the rain, TU Delft won overall in Class 1A

FORMULA STUDENT UK CLASS 1A

DUT Racing, one of two teams from Dutch institution TU Delft, utterly dominated Formula Student's alternative fuel class with its first all-electric car, the DUT11. It was the second fastest car overall in the Sprint and promised to be equally fast in Endurance, until the team fell victim to the Silverstone weather.

Fitted with twin AMK DT5 electric motors and lithium ion polymer batteries, the car was the lightest to finish the event, weighing in at just 178kg (GFR's lighter Class 1 car did not finish the Endurance section).

'At the start of the year we really looked at the competition and tried to make a car that scores well at all the events,' said a team representative. 'Moreover, we have tried to have the car designed as consistently as we can. We focus on every part. It was a great challenge to build, especially the battery pack. You easily underestimate the work that you need to put in, not only to design it but to build it as well. In the battery pack alone there are almost as many parts as in the previous combustion car.'

The monocoque is made from carbon fibre, which was manufactured by vacuum infusion. The overall design was extremely impressive and explains why they won the Design event and had over a 180 point lead overall.

Running in the same class but on a far smaller budget was the team from Manchester Metropolitan University. Its car came in at roughly £12,000 ($19,675), including the lithium ion phosphate batteries - some of the latest battery technology on the market today. 'We should be looking at the equivalent torque of a BMW M3,' said a team member. 'We're estimating it to be just under 250kg, which is not bad for the price really.' Not only is their budget small, but also their team, with only 10 people, and the car was built in just six months. 'A lot of people design a number of areas and sometimes they don't all quite fit together. One problem was running two batteries, but that wasn't going to last so we went back to having three, which meant altering the chassis.' The team's sponsors were essential to the building of this car, 'not just for the money, but for the expertise as well.'

The TU Delft car was powered by twin AMK DT5 electric motors and lithium ion polymer batteries. It was also very light, weighing in at just 178kg

MMU Racing believe that the environmentally friendly Class 1A is extremely important in the modern day motorsport world. 'We've been doing the petrol cars for a while and the majority of the team are electrical engineers, so it made sense to push it that way, which is something the university seemed to be interested in.'

Like any other form of motorsport, Formula Student is continually evolving to suit the demands of modern day society. As a result, for the 2012 competition Class 1 will merge with Class 1A. Not only will this highlight the importance of environmentally friendly motorsport technologies, but it will encourage students to get involved and begin designing the fuels and solutions of the future.

TECH SPEC

Class: FSAE - Formula Student class 1A

Weight: 178kg

Chassis: carbon fibre monocoque

Motors: two AMK DT5-30-10-EOW

Performance: 55kW/ 57Nm up to 4500rpm

Accumulator: 355V, 5.7kWh, 96S3P with a modular BMS

Transmission: spur gears, single step, final drive: 6.8:1, electronic differential

Suspension: double unequal length A-arm, pull rod-actuated, vertically oriented spring and damper

Brakes: four wheel disc system, full-floating steel rotors, adjustable brake balance, AP4226 calipers

Wheels: 6 x 10in custom aluminium centre, carbon fibre shell

Tyres: 18 x 6,0-0-10 LC0 Hoosier

Length: 2628mm

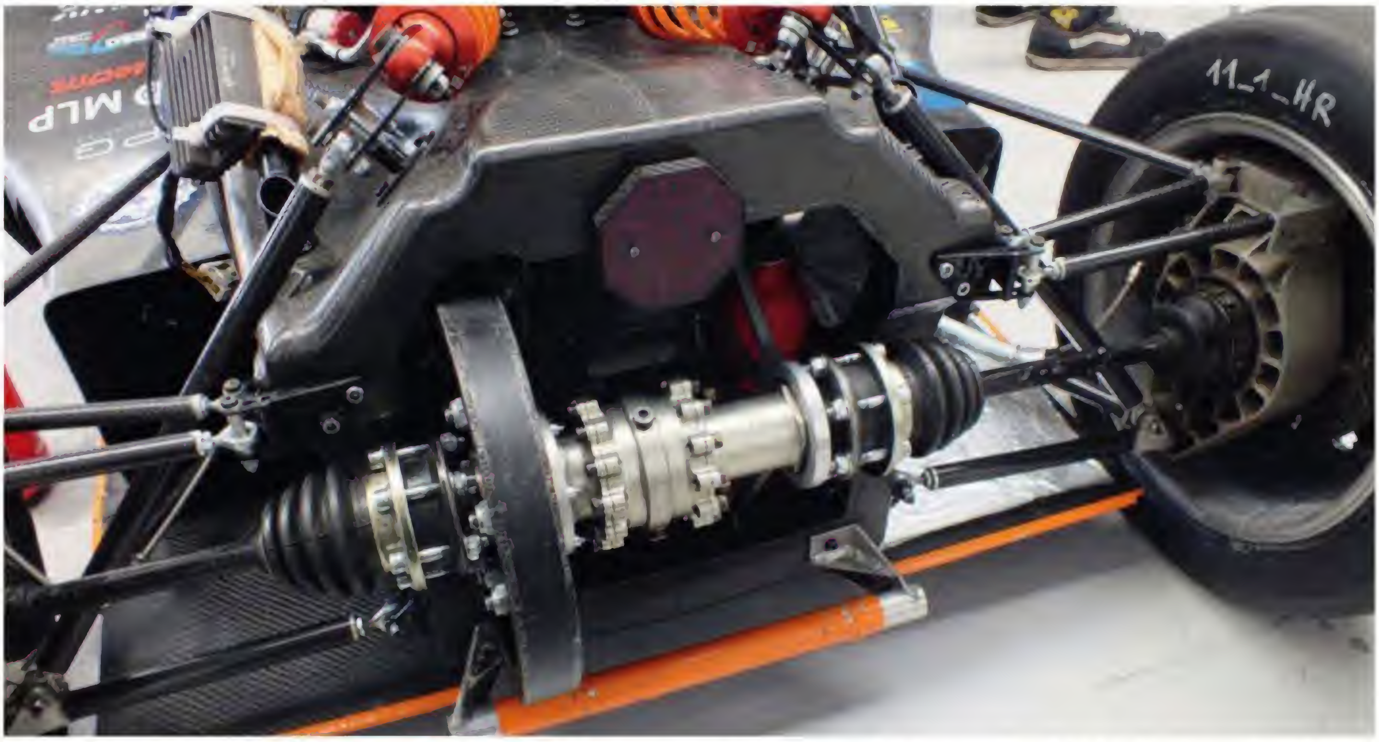
Width: 1406mm

Height: 1064mm

Wheelbase: 1540mm

The diff debate

Cost, weight, functionality and longevity are all considered by the student engineers when choosing which limited slip differential to use



The Drexler limited slip differential is considered the state-of-the-art by current Formula Student / FSAE teams, primarily due to its weight advantage

The Drexler diff has been a favourite for a long time. This is the previous generation Drexler diff that is still in use with some teams today

More than two thirds of the cars entered into class 1 and 1A at Formula Student utilised differentials from Drexler, Quaife or Torsen, but there is much debate over the best route to choose. Unusually (for Formula Student at least) the most expensive unit is currently the most popular, so we decided to ask the students the reasons behind their choices.

The basic aim of a differential is to provide a compromise between transmitting power from a single source to two driven axles and to allow independent rotation between the two driven axles (differentiation).

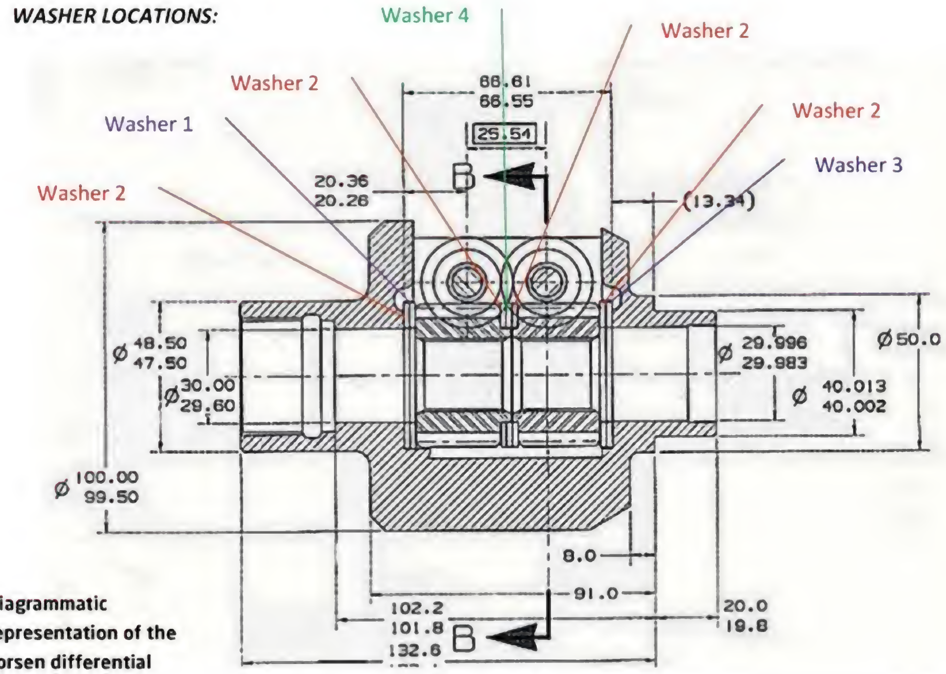
In the majority of designs, this is done with an automatic torque biasing (ATB) characteristic, which instantly reacts to unequal traction conditions between the driven wheels by delivering an increased amount of torque to the wheel with higher traction, ideally before the other wheel exceeds its traction limit, thereby avoiding spinning.

BY GEMMA HATTON

There are two main types of differential design used by Formula Student teams - Torsen and Salisbury. The Torsen (torque sensitive) design originates from the centre differential of the 1986 Audi Quattro, of which a developed form is still currently used in Audi models. The Torsen company is a differential manufacturer that has developed this design into a 'University Special', intended specifically for Formula SAE teams.

The Salisbury differential is custom made by German motorsport manufacturer Drexler, which also supplies a differential specifically for Formula Student. A third popular differential supplier is UK-based Quaife Engineering, which offers its standard motorsport unit. All three types are limited slip differentials.


Feel the DIFFerence
Customized High Performance Drivetrain Components
Driveshaft
Limited Slip Differential
Wheelhub System
DGB003 F3 Gearbox
DGB012 Gearbox (VW MQ350)
DGB006 FWD Gearbox
Crownwheel & Pinion
Upright
Customized Products
For further details, prices and delivery times
please contact our Sales Department
Email: info@drexler-motorsport.com
Phone: +49 / 851 / 851 6363-0
DREXLER MOTORSPORT
Drexler Motorsport GmbH
94121 Salzweg , Postgasse 12c , Germany
www.drexler-motorsport.com



Diagrammatic representation of the Torsen differential

DREXLER

Nine teams out of the top 10 Formula Student cars this year used the Drexler University Special, along with 42 per cent of the rest of the field. This design is extremely small, neatly packaged and has a quick response time. Furthermore, the whole unit only weighs 2.6kg, which is less than the lightest Torsen unit without its housing, the package weighing in at 2.7kg. Its pre-loaded range can be easily adjusted, which can make a big difference to performance, as TU Munich explain: 'Previously we had a Torsen differential, where if the inner wheel span the outer wheel then the differential began to work. The problem was when we drove into a corner on full throttle, the inner wheel started to spin, and only then would the differential start to block the inner wheel. The advantage of the Drexler is that it feels the moment of the wheel and so can be pre-loaded. When the driver drives in a straight line there is about 20Nm of pre-load, and in a corner, when the differential is pre-loaded with this torque, it stops the inner wheel from spinning immediately.'

Another benefit, according to Brunel Racing, is 'it offers more adjustability in ramp angles than many of the other differentials available.'

However, this advantage in performance comes at a price – about £1700 ($2800), compared to a Torsen, which costs only £300 ($490). Nevertheless, teams have found several ways to contain the cost. Firstly, it can be used more than once, as Brunel Racing has done: 'It's a carry-over part, so it's an absorbed cost. We're likely to use it again next year too, so over three years it starts to become more affordable.' Alternatively, Queen's Formula Racing from Belfast purchased just the unit and made the rest. 'We went for just the differential and not the driveshaft package, simply because of cost. We made our own intermediate shafts and CV joints to keep the cost down.'


UK-based Quaife Engineering is the only one of the top three differential manufacturers who do not offer a 'university special' for FS / FSAE applications

Other teams that were new to the competition, with little experience of Formula Student, such as TU Brno Racing from the Czech Republic, simply followed the trend. 'We knew that almost every team is using this type of differential, so we tried it,' they said. Drexler seems to offer the majority of teams what they need, even if it is expensive. But for teams on lower budgets who cannot justify the cost, they have had to look for alternative routes.

TORSEN

The Torsen unit is made up of 21 components and uses an invex gearing system made by Gleason and comprising six satellite gears (element gears) in mesh, with two central helical side gears.

Normally, the torque imbalance between the two driven wheels causes the system to 'try' and turn the low traction wheel faster than the high traction wheel. However, in the Torsen unit, the gearing structure results in a proportion of the torque that would originally have gone to the low traction wheel going to the high traction wheel instead, where it can be used and optimised. The invex gears increase the total amount of torque that can be transmitted by the driven axles under all traction conditions without restricting differentiation.

A major advantage of this design is that it has no effect on the anti-lock brake system because it does not support any 'wind up' (appreciable torque) between the drive axles during braking. Furthermore, the gearing and surfaces within the unit have different coefficients of friction so that wear is evenly distributed.

Lancaster Racing explain: 'Because it's a mechanical unit, it's very simple and there are other types of differential that are more complicated, like the hydraulic ones. The minute you add complexity to something like this, there's more chance of something going wrong. We dismissed the Drexler unit on the basis of cost, but the Torsen is also costly because it's built in America, so the shipping fees were almost as expensive as the differential itself.'

It's a similar story with the University of Manchester team, where the Torsen was considered the best option. 'We went with it because it gave us more favourable characteristics than some of the other differentials out there. We hope it's going to work better because the wheels have to start half slipping before stabilisation takes place. It's also got a good torque bias ratio for our car, and we weren't happy with some of the other systems that we have run previously, so we thought we'd try something different.'

The ultimate difference between the Drexler and Torsen differentials would appear to


The Quaife differential can be supplied in component form, allowing teams to adapt it to suit their requirements

be the cost - at least depending on the country of origin of the competing team.

QUAIFE

Unlike Drexler and Torsen, Quaife do not offer a 'university special' differential, instead supplying teams with the same unit as they do for their mainstream motorsport applications, which means teams then have to make their own modifications.

Len Unwin from Quaife Engineering: 'The automatic torque-biasing (ATB) characteristic automatically adjusts the ratio at which the differential locks up. However, it never locks up completely, so acts like an open differential and doesn't upset handling, whereas when using a plate differential, the handling has to be adjusted. Another benefit to the ATB is there is no friction affecting the performance and no wearing parts.

'Our differential gives the Formula Student team a chance to experiment, and it won't affect the rest of the capabilities of the car. It gives a lot of scope for the students to modify for their own use. It's nice for us to encourage students, but hopefully they'll get a good opinion of Quaife and want to use us again throughout their careers in motorsport. We have given them a unit that works, and works very well, but also one they can use their own imagination and their engineering skills on, which is what it's all about.'

One team that used Quaife differentials is Mobil 1 Team Sussex. 'We know Quaife offer a lifetime guarantee so we knew it was a good product to have. Also, in previous years we've had good support and technical advice from them and we've never had a problem with their differentials. It's a very compact unit, which is easy to fit and to design around. We had to get the right driveshafts and we didn't custom make those but instead got them off an actual car and modified them. In terms of moulding around the differential, because there was so much detail from the product itself and the size of the drawings it was easy to put it all together. It comes sealed as one package and all we had to do was add the grease. The differential is probably the most expensive part of our car but Quaife offer a very reasonable discount.'

As expected, price plays its part again, but also the time available. Some teams admitted they didn't have time to make the necessary modifications and so had chosen to purchase the more expensive Drexler unit instead.

HOMEMADE DIFFS

Is it more effective to modify and design your own differential because a Formula Student car is so specialised?

Global Formula Racing made its own clutch pack differential. 'It's externally adjustable with a pre-load, which is something we've been developing for a while. We looked at differential suppliers and it was something we strongly considered because there is a lot less effort involved. But we know everything about our design and so can adjust it the way we want. We saved a lot of money because most of the manufacturing was sponsored.' But GFR is a big team with major sponsorship, so has the resources available to design and make its own differential.

A team with a smaller budget that is also in the process of developing its own active torque system is Oxford Brookes Racing, but for different reasons: 'The Drexler is very expensive. We're sick of it. Every team runs one. We want to get away from that and start to innovate instead.'

Ultimately, the choice between Drexler, Torsen, Quaife or a custom made differential comes down to two things: the time available and the budget. If a team has money and little time then the Drexler is suitable. The Torsen seems to be used by teams with less time and less money, while the Quaife is cheaper still but takes longer to adapt. Looking at the success of GFR, it seems that if a team has plenty of both time and money they should certainly consider designing their own unit.

Alternatively, teams could go the Cardiff Racing route and run without a differential altogether, simply choosing to use a solid spool because they 'found it much better than a differential in a car with this short wheelbase.'

Hamburg worked with GKN to develop its own differential. A rare choice

QUAIFE®

POWER INTO MOTION

World leaders in the manufacturer of high performance drive-line and steering rack components, since 1965

COMPLETE GEARBOXES 5/6-speed sequential, H-pattern, heavy duty, dog engagement and synchromesh

GEARKITS 4/5/6-speed synchro, helical, semi helical, straight cut and dog

DIFFERENTIALS 350 fitments – all with Life Time Warranty

COMPLETE AXLES axle kits, half shafts

COMPLETE STEERING RACKS quick racks, rack & pinion kits

PLUS uprights, transfer units, reversing boxes, motorcycle gearkits

And much more for all types of vehicles

See our web site for more info and order on line at www.quaife.co.uk
For FREE brochure and information: Tel 0845 1307400 / 01732 741144
or email info@quaife.co.uk

nqa. ISO 9001 Registered UKAS

Quality Accredited
ISO 9001-2000 and
ISO QS9000-TS16949

It's not Voodoo

Refining tyre models for use in racecar simulation – part one

A question I am asked over and again is, 'Okay, I have my racecar tyre model, but what do I do to make it match up to real data?' The real reason I tend to get asked this question is that a great many people in racing are still coming up to speed with what a tyre model is, and how it actually works. Believe it or not, it's not voodoo magic, it's just a matter of knowing what's going on under the bonnet, and using a bit of common sense.

BY DANNY NOWLAN

In this article we are going to use ChassisSim to refine a bit of simulated data. I'm not doing this for a sales plug, it's just what I'm most familiar with. Don't worry if you use other simulation packages as the techniques are equally applicable. When refining our simulated tyre model, this is our order of attack:

- **Match the lateral acceleration and corner speeds**
- **Match the steering trace and hence the handling characteristics**
- **Match the longitudinal acceleration**

This approach has served me very well in achieving great correlation in countless formula.

Before we begin, though, we need to do a bit of preliminary maths so we can understand what we are doing. To refresh the reader's memory, let me present the ChassisSim v3 approximation again (see equation 1).

When refining the racecar

Equation 1

$$M_{TMax} = C_{M\_MT}(\delta_{camb},F_z)\cdot fn(F_Z,T_T)$$
$$F'_{MAX} = fn(F_Z,T_T)$$
$$M_T = fn(\alpha,F_Z,T_T)\cdot M_{TMax}$$
$$F_y = fn(\alpha,F_Z,T_T)\cdot C_{Fy\_MT}(\delta_{camb},F_z)\cdot F'_{MAX}$$
$$F_x = fn(SR,F_Z,T_T)\cdot \mu'_{TC}(\delta_{camb},F_z)\cdot F'_{MAX}$$

Table 1: parameter

Parameter	What it does
F'_{MAX}	This is the traction circle radius, or the Pacejka D term. This dictates your grip
$fn(\alpha,F_Z,T_T)$ & $fn(SR,F_Z,T_T)$	This is the normalised slip curve, or the other terms of the Pacejka term that dictates how the forces vary with slip angle and slip ratio. We'll talk about how this effects handling shortly
$C_{Fy\_MT}(\delta_{camb},F_z)$	This dictates your lateral camber sensitivity. This is the go to function to dial in lateral camber sensitivity and your traction ellipse properties
$\mu'_{TC}(\delta_{camb},F_z)$	This dictates the amount of longitudinal grip you're going to have to accelerate. This, combined with our camber function, is going to dictate how we accelerate

Equation 2

$$C_f = \frac{f}{\partial\alpha_f}\Big|_{\alpha=\alpha_f}\cdot(F_{m1}+F_{m2})$$
$$C_r = \frac{\partial C_r}{\partial\alpha_r}\Big|_{\alpha=\alpha_r}\cdot(F_{m3}+F_{m4})$$
$$C_T = C_f + C_r$$
$$stbi \approx \frac{a\cdot C_f - b\cdot C_r}{C_T\cdot wb}$$

tyre model the things we need to pay attention to are summarised in table 1, below left.

The next thing we need to keep in mind is the stability index. The formulation for this is shown in equation 2. (I've omitted the yaw rate term here, simply for ease of illustration). What this stability index is telling us that our understeer / oversteer is dictated by the difference between the traction circle radius multiplied by the normalised slip curve at either end. So to increase understeer, we either need to increase the traction circle radius at the rear or the slope of the rear normalised slip curve. The most direct way you can do this is by reducing the peak rear slip angle.

So without further ado, let's get started by looking at some actual simulated data. To illustrate this, consider figure 1 that shows an F3 car going around a rather bumpy circuit,

We need to get some housekeeping out of the way first. The first trace is speed, the second trace is throttle, the third and fourth trace is front and rear dampers respectively, the fifth trace is neutral steer and actual steer, and the final trace is lateral and longitudinal acceleration.

So our first port of call is to dial in the global grip. Let's just say, for the sake of argument, we wanted to increase the grip. To do this we simply go to the global grip factor and multiply it by 10 per cent. In ChassisSim you simply click on the tyre graphic and you'll see an edit box labelled Tyre force grip factor. The effect of this is shown in figure 2.

The grip factor is black, the baseline is coloured. As you can see, the effects are pretty obvious, with corner speed increasing everywhere. This does exactly what it is designed to do, so consequently is your first go to when dialing in grip.

But what happens if you increase grip factor and some corner speeds shift yet others don't? What's happening here is the simulation is telling you the tyre load characteristic isn't right. To diagnose this is easy. All you need to do is pull up a trace of the corner speeds with the tyre loads. You note the tyre loads and you simply increase or decrease the force at the appropriate tyre loads. A handy feature I've put into ChassisSim is a quick tyre force edit feature. You click on the Tyre quick start and you then click on the Click here to edit Traction circle radius. The dialogue will look like what is shown in figure 3.

You simply edit the tyre force at the appropriate load and away you go. If you really get stuck, the Tyre force estimation feature is a very handy tool to construct this curve.

> **"Don't get white line fever on having the perfect throttle trace"**

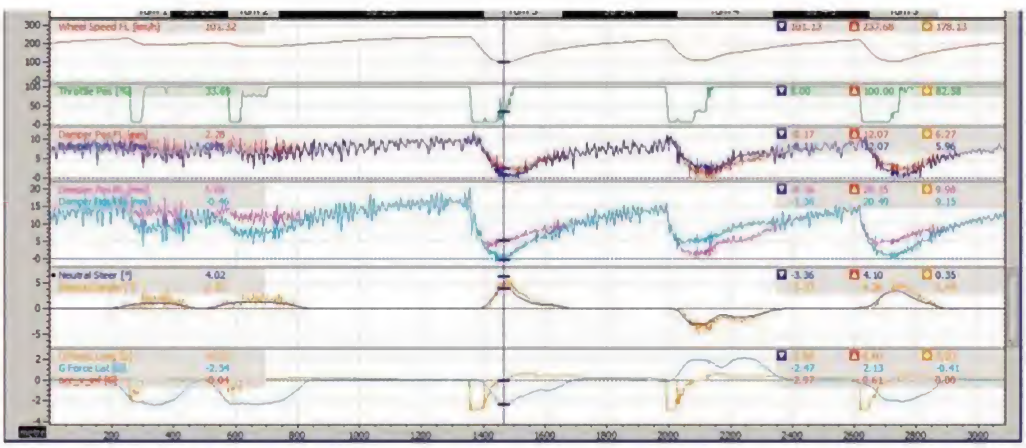


Figure 1: initial F3 run

STEERING TRACE

Our next port of call is to dial in the steering trace. Referring back to equation 2, our two biggest levers for this are going to be the global grip factor and modifying the peak slip angles, since this will change the normalised slip angle curve. Let's look at figure 1. The steering trace in this model is very neutral so, to increase the understeer, we are going to:

- **Increase the rear grip factor by 10 per cent**

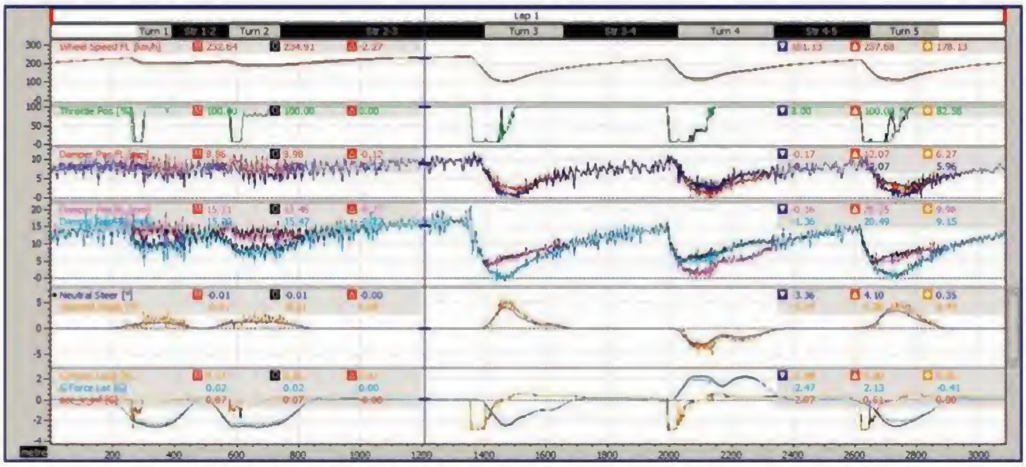


Figure 2: overlay of grip factor increased by 10 per cent

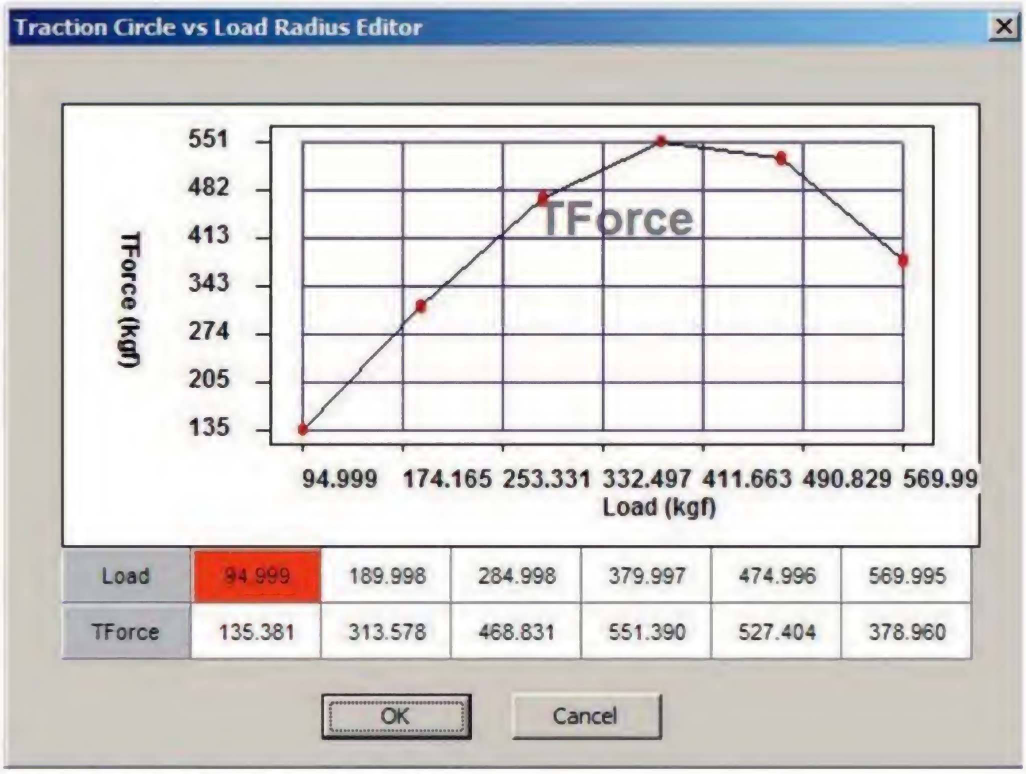


Figure 3: traction circle radius vs load quick edit

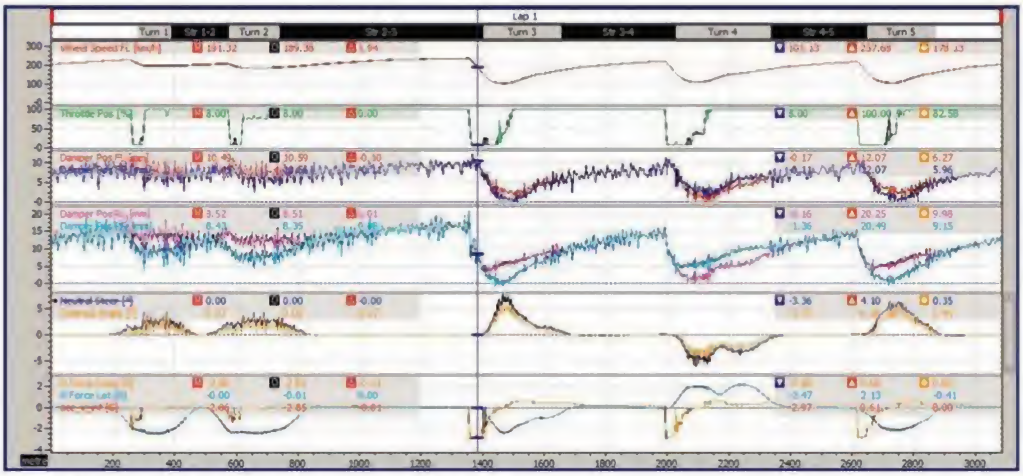


Figure 4: comparison of the understeer fix vs the baseline

- **Increase the front slip angle by one degree and reduce the rear slip angle by one degree**

The results are shown in figure 4. As you can see, the understeer fix is in black and our baseline is coloured. Looking at the fifth trace, which is steering, it has had a massive impact, with more steering lock having been added everywhere. While this example is a bit simple, it does nonetheless show how quickly you can dial this in.

Another critical for dialing in understeer / oversteer characteristics is rear slip ratio, particularly if you are running a limited slip or locked differential. The bottom line is if you are running a locked or limited slip diff, and either the diff changes are small or the locked diff option isn't having an impact on understeer, drop the rear peak slip ratio. This effectively increases the understeer effects at the rear because it magnifies the effects of the speed differences between the inside and outside tyre.

CAMBER SENSITIVITIES

Once the grip and understeer is dialled in, we now need to dial in the camber sensitivities and traction ellipse properties. Unfortunately, the only accurate read you are going to get is by looking at race data when you have made a camber change. Sorry guys, there are no short cuts here, though table 2 gives you some rough rules of thumbs to work from.

Note, this is only a rough guide and is simply there to get you going. Unfortunately, to dial it in will take time and some effort using your head to look at actual vs simulated data.

However, one thing I do want to cover in detail is dialling in the braking and acceleration characteristics. Your number one goal in doing this is to match the speed trace, but don't get white line fever on having the perfect throttle trace. It may make you look like a hero to team management and the driver, but the bottom line is we are interested in what is best for the car, and not making team management and / or drivers feel better. When dialing in

Table 2: three rough rules of thumb for camber sensitivity

Car	Opt camb	Sf_cam_y	Sf_cam_x	U_x Init
F3/GP2/LMP	3-4 deg	2-4	2-4	1
FIA GT/GT3	4-5 deg	2-4	2-4	1
Touring Car	5-7 deg	0.4 - 1	0.4 - 1	0.7 - 1

the longitudinal properties, my first port of call is multiplying the function to dial in my desired characteristics. If we want more acceleration, I increase this globally, and *vice versa* for reducing acceleration. To illustrate this, I'm going to increase the front function by 10 per cent and reduce the rear by the same amount. The effect of doing this is shown in figure 5, above.

For clarity, I've zoomed in on just one corner, but the speed and throttle trace are very revealing. The overall peak longitudinal *g* hasn't increased because that is being dictated by the maximum braking capacity of the car. That said, there is a slight increase in speed as we approach the final turn in section, which makes its presence felt in acceleration. Looking at the throttle trace, the black is our change and the green is the baseline. In some spots it's nearly seven per cent done and the speeds out of the corner drop by about a 1km/h.

In summary then, when dialling in our tyre model the following list is our order of business here:

- **Dial in the grip by adjusting global grip factors and, if necessary, the tyre force curve**
- **Dial in the base understeer / oversteer by taking deltas of grip factors and increasing / decreasing peak slip angles and slip ratios**
- **Dial in the traction circle and ellipse properties**

As you can see, this isn't terribly difficult to do. It comes as a consequence of the physics we outlined at the start in equations 1 and 2. It does take time, but anything worthwhile usually does. However, this is the knowledge you can use to win races. In part two next month, I'm going to show you how to extend this to temperature modelling.

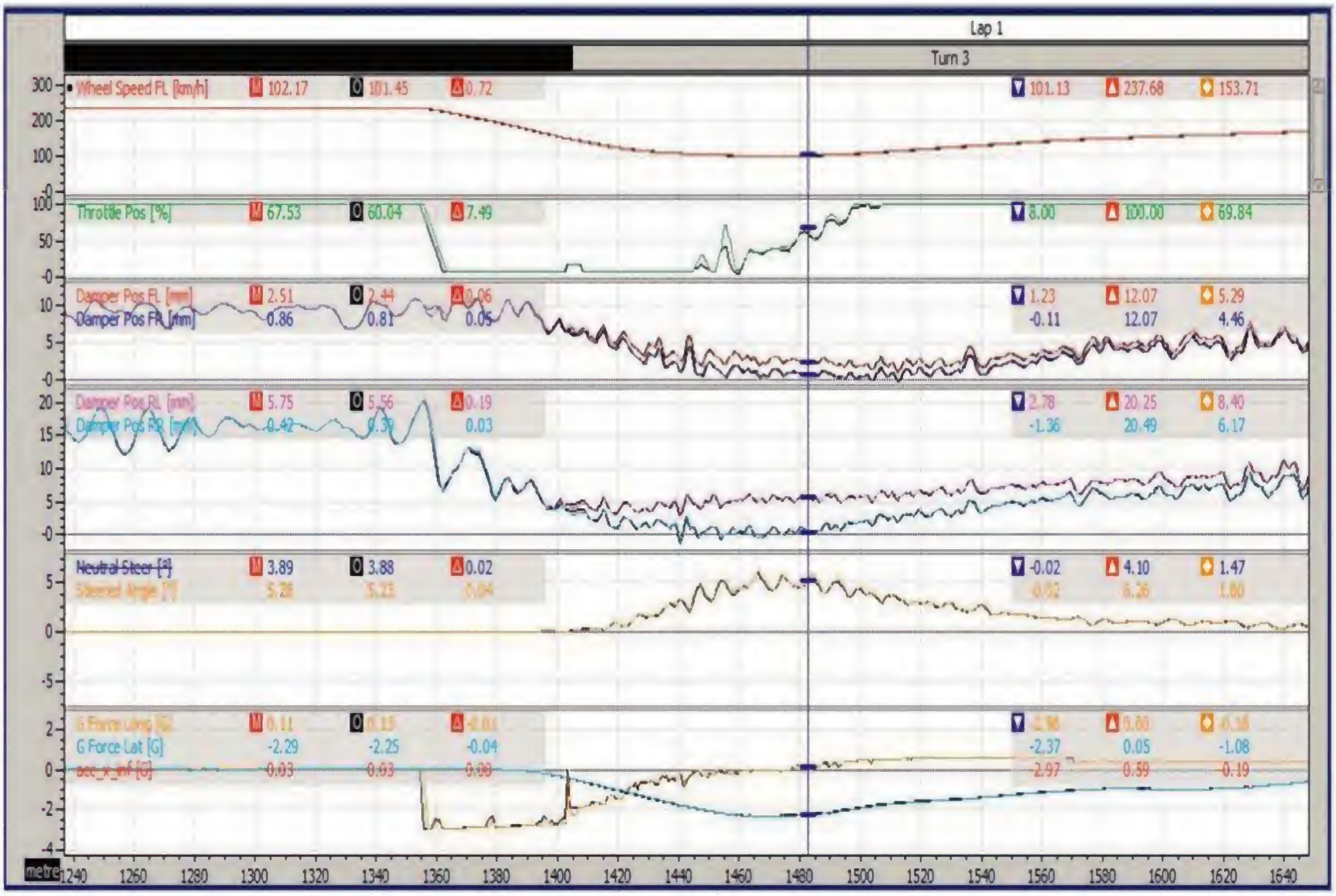


Figure 5: modified $\mu'_{TC}(\delta_{camb}, F_z)$ function compared to baseline


ECU/Exchange Loom/Throttle Body Packages available
Complex modern engine?
We can manage it
ECU solutions for:
Honda S2000 and K20A
Ford ST170 and Duratec
Toyota 2ZZ
BMW Single / Twin VANOS
Audi 1.8T and 5 cylinder
Chevrolet LS7.
DTA fast
Our ECU's are capable of dealing with the most complex of modern engines without the need to change sensors or sacrifice key features such as variable camshafts.
S series
Get the very best from any engine and from only £495.00 + VAT.
DTAfast, 10 Boston Court, Kansas Ave, Salford M50 2GN
Tel: +44 (0)161 877 1419 Fax: +44 (0)161 877 7086
Email: office@dtafast.co.uk Website: www.dtafast.co.uk


Snapdragon
ENGINEERING, LLC
ÖHLINS
Contract manufacturing of high value, high performance components to an international clientele in formula, sports car and rally competition.
Authorized sales, service and testing of Ohlins racing dampers.
Exclusive North American agents for Farringdon data acquisition systems.
413.256.0861 Amherst, Massachusetts, USA www.snapdragonms.com


MOCAL High performance air to oil coolers
Oil cooler installation kits
Remote filter heads & take offs
Electric water pumps, release engine power
Dashboard gauges
Oilstats control oil temperature for more power & mpg
LAMINOVA oil to water coolers
Electric oil pumps for transmission cooling
FACET
Holley & Facet fuel pumps
Custom hoses for oil, fuel, brakes & coolant, Aeroquip, ProGold, Moquip & Speedflow
World biggest filler cap distributor
Early warning switches & bulbs
Manufacturers of MOCAL & Moquip oil cooling equipment. Distributors of automotive fluid control products. Online shop @ www.thinkauto.com Catalogue £2 refundable.
Think Automotive
www.thinkauto.com
292 Worton Road, Isleworth, Middlesex, TW7 6EL
Tel 0208 568 1172 Fax 0208 847 5338
Email info@thinkauto.com

Bedford Autodrome: motorsport on an industrial scale

Entrepreneur and one-time Formula 1 driver, Jonathan Palmer, has long been synonymous with operating successful motorsport businesses. His current UK-based Palmer Sport and Motorsport Vision operations can lay claim to four of Britain's great racing circuits - Brands Hatch, Cadwell Park, Oulton Park and Snetterton - all of which have seen extensive investment during MSV's stewardship. In addition to this, the company owns the Bedford Autodrome facility and runs the FIA Formula 2 single-seater championship, along with a very successful corporate track day operation.

It is the Autodrome, however, that is the heart of the Palmersport / MSV operation, and it is unlikely there is a facility like it outside NASCAR. In the centre's expansive workshops, the entire 24-car F2 grid is maintained between races. Each car is stripped by a dedicated team of mechanics, before being serviced and re-assembled, with the process taking place once every two weeks during the racing season. On the opposite side of the workshop are a host of other competition cars from the Palmersport track day business, which are also maintained and serviced on a daily basis.

The Palmer JPLM was developed specifically for novice driver experience days and training sessions

The vista that greets anyone entering the shop floor is arresting, with up to 50 cars in residence at any one time.

JPLM - RS SPYDER LOOKALIKE

The latest addition to Palmersport's fleet is the JPLM, a two-seater Sports Prototype, designed to be used for track days and driver tuition. For members of the public (and a fair few racing drivers) this car is as close to a true LMP as one is ever likely to get. Featuring an effective aero package and motivated by a 3.0-litre Jaguar V6 producing 265bhp, transmitted through a Hewland semi-automatic gearbox, it has all of the components you would expect to find on a thoroughbred competition machine. The car is a development of the Palmersport Jaguar JP-1, the company's previous two-seat

Transport iNet provides MIRA wind tunnel time

Three UK companies have benefited from involvement with the Transport iNet organisation, thanks to it providing wind tunnel time at the MIRA test facility. The three companies - Cougar RED, Great British Sports Cars and Norton Motorcycles - all took up the opportunity for a two-hour slot in the wind tunnel funded by Transport iNet. This enabled each team to carry out important tests with advice on hand from the MIRA aerodynamicists. Mark Taylor, director at Cougar RED, which offers manufacturing services to the motorsport industry, commented: 'Our wind tunnel test was to provide data on the aerodynamic efficiency of various bodywork designs. This information was vital to our future plan of developing our own motorbike and it allowed our rider to see how small changes in body position affect airflow, and ultimately performance.

'This was a really worthwhile experience for us, and we wouldn't have been able to do it if it wasn't for the support of Transport iNet.' Georgette Hall, Transport iNet advisor, said: 'Our remit is to provide support, as well as opportunities for innovative companies to further develop their business. The MIRA wind tunnel is a fantastic facility and the expertise on offer has been invaluable for these companies. I'm really pleased that our clients had a worthwhile experience and look forward to our continued work with them.' For more information on iNet, visit www.eminnovation.org.uk

special, itself spawned from the Zeus Challenger sports racer. While the basic layout of the two cars is the same, the JPLM is engineered to be wider, in order to accommodate a range of driver sizes, and produces

> "up to 50 cars are in residence at any one time"

a considerably greater level of downforce than its predecessor. The majority of Palmersport's business comes from the corporate sector, with companies paying substantial amounts of money for track day packages. It was therefore also important for the car to look 'right', and following the re-design it is no coincidence that it bears a close resemblance to a certain German LPM2 contender.

In order to withstand the rigours of being driven by novices on a daily basis, with the inevitable damage and high mileage this entails, the JPLM is designed to be both sturdy and easily serviced. It is here that the compromises over a pure racecar are apparent, with components specified for durability rather than ultimate performance. The suspension geometry was also substantially revised from the original Zeus design, to provide a more stable and forgiving platform that could be exploited by inexperienced pilots. In addition, all of the cars feature dual controls on the throttle and brake, allowing instructors to step in should things get out of hand.

The end result is a fair representation of a true sports racer. The steering is heavy, and gets heavier through fast turns as the downforce builds. Over exuberance can unsettle the chassis, but it is benign enough to be easily caught and corrected. Combined with the acres of run off at the Bedford facility, and an instructor in the passenger seat, connected through an intercom giving instructions on how to get the most out of the car, it encourages drivers to push to their limits.

TECH SPEC

The JPLM

Chassis: tubular spaceframe, carbon / glass fibre bodywork

Engine: Jaguar 3.0-litre V6, 24v, naturally aspirated

Power: 267bhp

Gearbox: Hewland FTR six-speed sequential, semi-automatic paddle shift

Top speed: 165mph

Zircotec cools Astons at Nürburgring 24 Hours

Advanced ceramic coating technology played its part in ensuring that Aston Martin's latest V12 Zagato endurance racecar was able to stay cool at the epic Nürburgring 24 Hours. The coating, derived from Zircotec's ThermoHold-based ceramic, was selected by Aston Martin as a highly effective, durable, yet lightweight method of reducing under-bonnet temperatures at the 25km Nordschleife track. The use of Zircotec's advanced coatings on the new Aston Martin reflects the growing use of such coatings to manage heat both on the road and track. With its origins in the nuclear industry, Zircotec's ThermoHold technology is applied to the exhaust system by plasma spraying and combats heat radiation. The resultant lower under-bonnet temperatures improved reliability and prevented heat damage to bodywork, fuel and electrical systems. Keeping heat inside the exhaust also lowered cockpit temperatures, improving driver comfort and safety.

UK business secretary visits Group Lotus

UK secretary of state for business, Vince Cable, took time to visit Group Lotus' headquarters in Hethel, Norfolk recently.

During his tour of the facilities, Cable was shown the design and styling studio, with details of the future product line up, as well as the current car production lines. Commenting on his visit to Group Lotus, Cable said: 'Lotus is a very successful company. It's doing very well – exporting a lot – with a great deal of ambition. 'I've seen the new models and I believe that this is the best of British industry, with very high levels of skill and engineering quality. Through its cars, motorsport and engineering divisions, Lotus make a key contribution to the UK automotive sector and the wider economy through the exports of its iconic cars and its world-class design engineering consultancy.'

It wasn't all hard work and business talk, though. Undoubtedly the highlight of his visit was a chance to show off his driving skills behind the wheel of an Evora S on Lotus' own test track. Speaking about his track time, he commented: 'It was absolutely great, it's a wonderful car, very manoeuvrable and great fun. And of course, very fast. When I was a teenager I used to go to aerodromes in Yorkshire where the first generation of Chapman's Lotus cars competed with Jim Clark at the wheel, so this is really a lifetime ambition I've fulfilled here.'

BRIEFLY...

MSA issues amendment to Formula Cadet engine tender

The UK Motor Sports Association (MSA) has issued a revised Formula Cadet engine tender document, featuring an amendment regarding the provision of flat spaces for bar codes on the engine. The amended tender document can be accessed on the MSA website. Manufacturers are reminded that notices of intent must be sent to MSA technical administrator, Joe Hickerton, by post or email by no later than 1 August 2011, as detailed in the tender document. For further information, contact the MSA technical department.

Red flag for Red Bull

The Red Bull Racing NASCAR team has announced that it will shut at the end of the season, but team manager Jay Frye is actively seeking investors to take over the operation from Red Bull in an attempt to keep the two-car team intact. Such a plan could also involve Hendrick Motorsports supplied engines and chassis.

Drayson and Lola's electrical connection

British racecar builder Lola is to build an all-electric sports prototype racer with sportscar team and electric vehicle motorsport specialist Drayson Racing Technologies.
The car, which is to be designated the Lola-Drayson B12/69EV, will be developed by the two companies with Drayson taking care of the electric drivetrain and Lola the chassis.

STRAIGHT TALK

The fast track to the right skills

CHRIS AYLETT

They don't teach racecar engineering at school, but they do at the MIA race engineering school

For years now, race engineering skills have had to be learned 'on the job', which takes time and can be expensive. Many people want to encourage the learning of the special skills needed to become a race or rally engineer and similarly, many young people approach me and ask where they can get the experience that will help them become a race engineer.

But to enthusiastic, keen, young people the idea of having to serve out their apprenticeship stage by stage over years ahead is an unattractive proposition.

So the MIA race engineering school was born, and we issued our first diploma to successful students earlier this year. Sixteen young people received a Diploma of Race Engineering, which outlines on its reverse side exactly what the course taught them. More importantly, we have been determined to work hard to talk to employers to ensure the course content reflects exactly what is needed in today's business.

The best way we could do this was to engage two young race engineers who are at the top of their game. Dan Walmsley and Jay Davenport from Strata and Arden Motorsport respectively, filled this role perfectly and proved themselves to be excellent tutors.

The course is open to engineering graduates, technicians who have qualifying experience of motorsport and race engineers who simply want to learn more. So successful was the inaugural running of the course that it will be run again, in the same format, in late November this year.

The course is in fact two courses, each of which occupies two full days over separate weekends. To gain the MIA Diploma of Race Engineering, delegates must attend all four days. However, if they are unable to do so at one time, then they can come back at a later year and pick up the second part of the course to obtain the full Diploma. The costs are kept reasonable at £300 per day and the venues chosen are memorable, including Mercedes GP Petronas HQ, for example.

In the social time, we have also arranged for race engineering leaders, such as Frank Dernie and Pat Symonds, to drop in to meet the students and explain further their lives as a race engineer.

We had a tremendous response from our 2010 delegates, every one saying the course was informative, relevant and well planned and that the presenters showed real enthusiasm and knowledge of their subject. They also all said they would recommend it to others.

We are delighted to say that at least one of our graduates this year immediately turned the Diploma into fulfilling their dream, and are now employed as a full a time race engineer.

The MIA will be extending the scheme over the next 12 months to include rally engineering, possibly at a WRC headquarters in the UK, and also a one-day crash course for those currently in motorsport education. This was added as it was felt some students could benefit enormously from the knowledge and wider understanding of race engineering, but could not afford either the cost or time involved in taking the full Diploma.

All these ideas for development of the MIA schools have come from the students themselves. We also listened to the employers, who are delighted that they are receiving applications from young people who have been taught from current experts, and also that the course content is available for future employers to read so they know its relevance, as opposed to some vague general motorsport qualification. The reaction from our friends in the academic world has also been very positive. They know the limitations of the mainstream education facilities and also that the skill sets required cannot always be acquired from today's professionals. Most do an excellent job with the resources they have available and feel that this supplement - paid for by the students themselves - will help accelerate employment in motorsport engineering.

I feel we have found a really valuable service that helps teams and employers, as well as potential race engineers, and look forward to this growing in the years ahead. Should you require details of the MIA schools, please go to www.the-mia.com.

> “the course content is available for future employers to read”

Brembo go trucking

Brake manufacturer Brembo has become the official supplier of Truck Sport Lutz Bernau (TSB) team in the FIA European Truck Championship. The agreement signed with the TSB team marks Brembo's entrance into this highly competitive arena and is a significant step that, after Formula 1, MotoGP, Superbike and NASCAR, further consolidates the company's position as a leading motorsport supplier. Brembo's multi-year experience in the development of high performance racing solutions makes the tie up with Truck Sport Lutz Bernau team a natural development of its activities. The challenge facing Brembo is a substantial one, both literally and metaphorically, as each racing truck weighs in at over five tons and packs a 1000bhp punch, requiring a highly specialised braking system.

Wirth Research sells off F1 assets

The Wirth Research Group, headed by engineer Nick Wirth, has sold its F1 racing business to the Marussia Virgin Racing team. The sale included its leading edge technical centre in Banbury, Oxfordshire. The move follows the company's split with MVR, after the team expressed frustration at the MVR-02's lack of pace during the 2011 F1 season. The Wirth Research companies will be continuing to focus their efforts in the motor racing industry under the leadership of Wirth, but concentrating on its successful Sportscar projects.


TRADE-ONLY DAYS
12 & 13 JANUARY 2012
AUTOSPORT
INTERNATIONAL
Engineering Show
In association with Racecar engineering
12 & 13 January 2012 NEC Birmingham
Santander
brembo

A show for winners

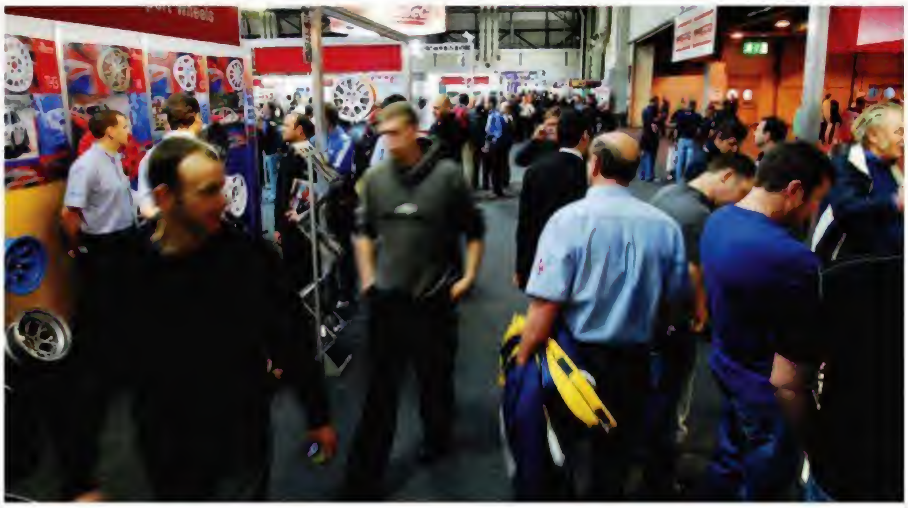
Tony Tobias is an unforgettable character. Anyone that has met him would not dispute his energy and passion for the motorsport industry. It's this love for the sector that makes him a truly unique member of the team that organises Europe's largest motorsport trade show, Autosport International, which takes place at the National Exhibition Centre in Birmingham, UK on 12-13 January 2012.

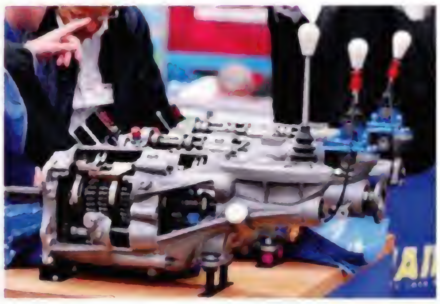
Affectionately termed 'Tony's living room' by Wilfred Eibach, president of Eibach Springs, Tony is a real driving force for the show's trade area and, as preparations for next year's event get underway, we spoke with him to find out what life has been like being part of such an important event for the industry.

'I've been involved since the first year when there were 45 stands, now there are over 300,' said Tony. 'Of course, it can be extremely busy and there is a lot of work to do, but if I didn't love it I wouldn't still be here!

'We have some very loyal exhibitors that come back to the show year after year. Among these are Quaife, Xtrac, Deutsche, Eibach and Capricorn, to name just a few. This year we also have Alcon and Ricardo returning, which just shows that Autosport International is a show that delivers value and is very important for those providing services in the area. We even had Steve Lewis from Performance Racing Industry (PRI), America's show for those within the sector attend in 2011. He was very impressed.

'The Manufacturing Technology area is a relatively new section of the show and has become very successful. Since its inception it has continued to grow and has widened the attraction of Autosport International further.'

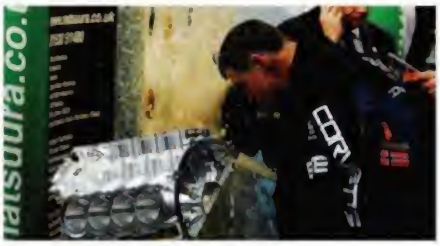




Tony's recognition for his work with the show and its exhibitors has extended beyond the confines of the motorsport engineering sector, and he has even paid a visit to Buckingham Palace for his contribution to the UK motorsport industry. He was also honoured with the 2004 Motorsport Industry Association (MIA) Excellence Award, which is given to companies or individuals who have gained the respect of their peers within the industry.

'I'm very proud of the show and the work that everyone does to ensure all visitors and exhibitors are satisfied and return,' continued Tobias. 'Through the years there have been a huge number of highlights - too many to mention in fact - but, starting from the top: "Mr E", Bernie Ecclestone, coming to the show has certainly stayed in my mind. As has having other F1 grandees attend, such as Patrick Head, Ron Dennis and Ross Brawn, as well as many other leading Formula 1 designers and suppliers. This is a real honour.

'Of course, the 20th anniversary party for *Racecar Engineering*, which took place at the 2010 show, was a very important moment. A whole host of the staff that have worked on the magazine since its inception were there to celebrate alongside exhibitors with champagne



on the stand, including three former editors - Quentin Spurring, Charles Armstrong-Wilson and Graham Jones.

'The show also hosted the launch of the first Force India F1 car, where several hundred media attended, which of course was brilliant to see. However, amongst all of these, my proudest moment was walking then secretary of trade and industry, Lord Heseltine, and honorary president of the MIA, Lord Astor, around Autosport International, introducing them to exhibitors and showing some of the products and services on offer.

'The show really has become key to the industry and truly is an event that should not be missed. Without the expertise, the drive and care that they have, the show wouldn't attract the returning exhibitors and visitors. I'm so proud to be part of a show that is different, with a sales team that isn't all about turning over numbers but about ensuring that everyone has a great experience. It's definitely a show for winners, run by an award-winning team.'

Companies interested in exhibiting at Autosport International 2012 can find more information by calling **+44 (0)20 8267 8307**. Tickets for trade visitors are also now on sale. To book call **0845 218 6012** or visit **www. autosportinternational.com/trade**

Blown diffusers

Why the FIA should decide against exhaust-driven floors

Blown diffusers have been a hot topic in Formula 1 since the Spanish Grand Prix, and the FIA has deliberated over whether or not it can ban them. Prior to the German Grand Prix in July, the FIA's Chief technical delegate, Charlie Whiting, answered questions on the FIA's stance on the matter.

Was the investigation initiated by the FIA or did it come from an F1 team?
The matter was initiated by the FIA when facts concerning some quite extreme, and hitherto unseen, engine mapping began to emerge. We were concerned that exhaust tailpipes were being positioned and engine maps created with the primary objective of improving the aerodynamic performance of the car. Prior to that it had been assumed that any aerodynamic benefits were incidental to the primary purpose of the engine and its exhausts ie that of generating torque.

Why did you decide to act?
Because not only did we consider such extreme mapping to be arguably illegal but also, if such freedom was left unchecked, it would result in the teams incurring significant further development costs during the course of the season.

Is the off-throttle blown diffuser illegal under the 2011 technical regulations?
We certainly consider them to be questionable. However, the key is whether or not we consider any particular engine map to have been created for any other reason than the generation of engine torque.

Is its illegality an unforeseen side effect of the rule to ban f-ducts?
No, the two are unconnected.

Why was it not possible to simply introduce blanket limits on hot and cold blowing and apply them equally to every car?
This is precisely what we attempted to do in the first communication to the teams on 12 May. However, it soon became apparent that the matter was more complex than initially thought. The main problem was the difficulty in ensuring that teams were not prevented from using existing legitimate strategies, whilst ensuring that the extreme mapping was no longer possible. This is why we postponed the introduction of the measures until the British Grand Prix. There are also a number of other mechanical factors to take into account, such as the architecture of the engine throttles themselves (butterfly or barrel operation).

What measures were introduced for the European Grand Prix in Valencia?
Whilst examining the engine maps from several teams it became clear that extreme

Renault's R31 exploited the hot blown floor concept in the most extreme way, with its exhaust exits at the front of the sidepods

solutions were being used for short times in qualifying and then being changed for more durable solutions for the race. We felt that this was certainly against the spirit of the *parc fermé* regulations but, more importantly, the relevant regulations simply do not allow changes to be made whilst the cars were being held under *parc fermé* conditions. Connections to the car may be made, and electronic units freely accessed, but no changes to the set up of the car can be made. We therefore informed the teams on 14 June that we would take these measures in Valencia. This was done, and cars run accordingly, with very few difficulties.

Why was the matter still being discussed over the weekend of the British GP, and why did the clarification change from Friday to Saturday?
The matter was still being discussed because one engine manufacturer [Renault Sport] was reluctant to run with the settings we had imposed and continued to try and convince us that they would require alternative settings in order to maintain their perfect reliability record. At the last minute additional information was provided to us, which we felt would be hard to refuse having already made a small concession to another manufacturer [Mercedes Benz HPE]. However, further discussions on Friday evening and Saturday morning resulted in us deciding that we had conceded too much and, to be fair to the manufacturers who had presented cars in what we considered the correct configuration, we should revert to the specification we had specified in our note to the teams on 20 June. This is how all teams then ran on Saturday and Sunday in Silverstone.

What was the purpose of holding two Technical Working Group meetings in Silverstone?
Following the events of Friday, the FIA president felt it would be useful to have an open discussion in order to see if consensus could be reached. Following these two meetings there was unanimous agreement among the teams to revert to the engine mapping regime used in Valencia ie freedom on settings but no changes to the maps between qualifying and race. This was felt to be the most sensible solution to a very complicated matter as the possibility of finding an alternative solution, which would be fair to all engine manufacturers, was becoming increasingly unlikely.

If the FIA had not acted, would there have been a protest?
As all the teams had reached consensus there would have been no point in doing so.

Has the matter now been settled then?
Yes, and all cars will run under 'Valencia conditions' for the remainder of the season.

Are there likely to be any protests now that this matter seems to have been settled?
We are optimistic that there will be no protests over any engine mapping and exhaust tailpipe issues this season. In addition to the main part of the agreement reached in the TWG meetings, it was also agreed that no team would raise a protest against another on these matters for the rest of the season.

What will happen in 2012 and beyond?
The teams have already agreed to strict constraints on exhaust tailpipe position, which will result in them exiting the bodywork much higher up and no longer in the vicinity of the diffuser. Therefore, any aerodynamic benefit from exhaust gas flow over bodywork will be kept to an absolute minimum. Engine mapping will remain free (within the existing constraints of the FIA SECU) as, with the exhaust tailpipes in this new position, it is felt that any aerodynamic benefit will now be incidental to their primary purpose.

Low-mounted, oddly-shaped exhausts such as this have been a feature of Formula 1 in 2011. They will be outlawed next season

COMMENT

Just before the Chinese Grand Prix, engine supplier Renault Sport F1, made something of a surprising announcement. To get the best out of front-exiting exhausts and other blown floor concepts, the cars use as much as 10 per cent more fuel. To power a blown floor effectively and generate additional downforce, an engine must produce significant amounts of exhaust gas. Simply put, the more fuel burned, the more exhaust is produced, and therefore potentially more downforce. It is startling that the French engine manufacturers would highlight this in the way it did - in a press release - as it was pretty much an open invite for the FIA to ban these exhaust layouts.

There are three main reasons why the FIA should have banned the concept properly: firstly, the blown floors are expensive to develop, requiring complex wind tunnel / CFD work and trick composite production methods. Look how much McLaren struggled with its solution, before giving up on it.

Secondly, the blown floors and complex exhaust layouts increase downforce and, as a result, increase apex speeds, so to keep the speed of the cars under control it seems an easy thing to outlaw. But apparently not.

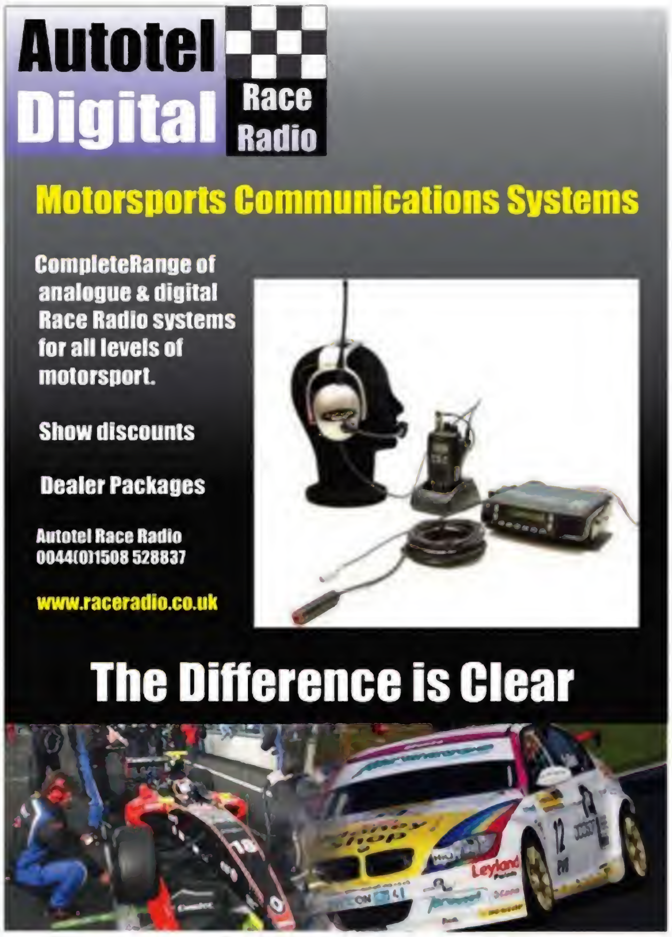
Thirdly, and most importantly, a ban would bring motorsport in line with manufacturers' general trend towards being greener. It's hard to justify burning 10 per cent more fuel per session just to go around a corner slightly faster. It equates very roughly to around 15 litres of fuel per car per race. If all cars on the grid had blown floors and all used the same amount of extra fuel, that's around 360 litres of fuel per race and around 7000 litres over the course of a season. Imagine the green lobby seizing on it, just at the time when the entire automotive industry is trying to talk up its green credentials.

It simply cannot continue now that the consumption increase is out in the open. It would be easy for the FIA to regulate exhaust outlets, by stating two symmetrical outlets exiting within 500mm of the rear of the engine, or similar.

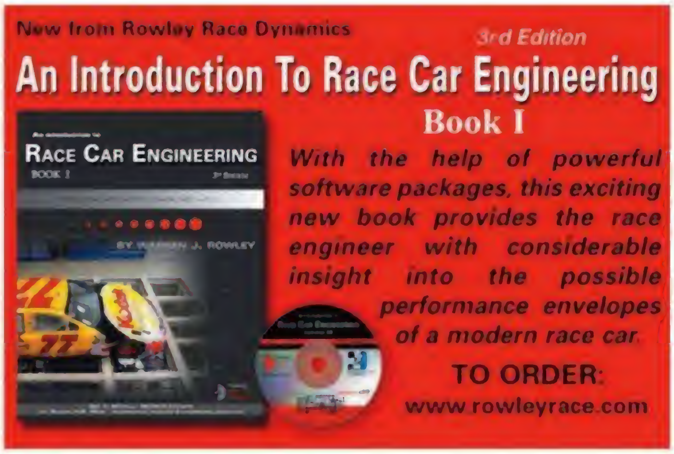
The flip side is that there is some genuine innovation is on display but, for 2012, it seems that blown floors will be outlawed. Perhaps that was what Renault Sport F1 wanted.

At the Valencia pre-season F1 test, a senior Renault engine man told *Racecar Engineering* that it was difficult to cater to all the different layouts employed by its teams. And, while he did not say it outright, the implication was clearly that the increased costs faced by the engine supplier were hard to stomach. Mind you, it could be a case of making something out of nothing... ***Sam Collins***


Wm. C. Mitchell Software - Racing by the Numbers
Introducing version 4.02 of the WinGeo3 Suspension Geometry program with Force-based Roll Centers
----- explained! -----
www.MitchellSoftware.com
800-844-7296 from USA and Canada
125 East Plaza Drive, Suite 117
704-660-0330 voice
704-663-0085 fax
Mooresville, NC 28115 USA


Autotel Digital
Race Radio
Motorsports Communications Systems
CompleteRange of analogue & digital Race Radio systems for all levels of motorsport.
Show discounts
Dealer Packages
Autotel Race Radio
0044(0)1508 528837
www.raceradio.co.uk
The Difference is Clear


Dunnell Engines
Duratec and Zetec engines and components for road and race
Duratec full race and rally applications
Knut Ove Borseth - 2009 European Rally Cross Champion Using our latest Duratec RX series engine
duratec
Duratec Engine
2.0-2.5 Litre
200-330 BHP
zetec
Zetec engine
1.6, 1.8 & 2.0 litre
175-270BHP
Complete engine & component development
www.dunnellengines.com
Tel: +44 (0)1449 677726 Email: info@dunnellengines.com
Unit 10 Tomo Business Park, Creeting Rd,
Stowmarket, Suffolk, IP14 5AY, England


New from Rowley Race Dynamics
3rd Edition
An Introduction To Race Car Engineering
Book I
RACE CAR ENGINEERING
With the help of powerful software packages, this exciting new book provides the race engineer with considerable insight into the possible performance envelopes of a modern race car.
TO ORDER:
www.rowleyrace.com


ATL
RACING FUEL CELLS
PROUD SUPPLIER TO EVERY F1 TEAM!
PLUS OFFICIAL SUPPLIERS TO:
>BTCC (BRITISH TOURING CAR CHAMPIONSHIP)
>STCC (SWEDISH TOURING CAR CHAMPIONSHIP)
>DTM (DEUTSCHE TOURENWAGEN MASTERS)
ATL UK
Tel: +44 (0)1908 351700
sales@atlltd.com
www.atlltd.com
ATL USA
Tel: +1 201 825 1400
atl@atlinc.com
www.atlinc.com


MOTORSPORT QUALITY ROD ENDS
AND SPHERICAL BEARINGS
INTERNATIONAL STOCKING DISTRIBUTORS
AURORA® · RODOBAL® · Seals-it®
broadest range
in Europe
metric and inch sizes
ACCESSORIES:
side seals
protection boots,
jam-nuts
bearing installation tools
Getecno srl
16141 GENOVA - Italy
fax +39 010 835.66.55
phone +39 010 835.60.16
contacts in English, Deutsch, Français, Italiano
www.getecno.com - info@getecno.com


QA1
QA1
QA1
MBE
MBE
STT
STT
STT

Seishi Ikeki

INTERVIEW

Q When did Falken Tyres first enter motorsport in Europe?
Falken started its motorsport activities in 1999 by taking part in the 24 Hours at the Nürburgring.

Q What other series are you currently supplying tyres to around the world?
Our tyres are used in both the American Le Mans Series [GT2] and the VLN Series [an endurance series based at the Nürburgring] and the 24 Hours at the Nürburgring. Our road tyres are also used in competition, including Pikes Peak with 'Monster' Tajima and a number of drifting competitors use our flagship FK452 performance road tyre.

Q Why is motorsport so important to Falken?
Motorsport is very important because it allows our engineers to gain experience and knowledge under extreme conditions that can be used and adapted for series production. Furthermore, motorsport offers us the unique chance to use cars and equipment that demonstrates the maximum performance of what is technically possible with Falken technology, way beyond the levels experienced on the road. The series we are involved in are chosen because they provide the best arena to develop technologies that have relevance to our road car tyre development. Tyre longevity and consistency are attributes that are relevant to success in endurance racing *and* the road tyres we sell.

Q Where do you make your race tyres?
All our race tyres are made in Japan at our factory in Nagoya.

Q You have entered the Nürburgring 24 Hour Race for many years. What tyre development benefits to you gain from the event?
The Nordschleife of the Nürburgring is unique. This racetrack offers every conceivable challenge: jumps; sharp curves; long straights; undulations; surface changes and curvy sections. That means tyres which are used on the Nürburgring are exposed to a constantly changing set of extreme conditions. It's this set of conditions that provides our engineers with a proving ground to test compounds, different constructions and acquire the data. The track is favoured by car manufacturers who buy our tyres for their road cars. If we can show success at a place that they fully understand, it helps to present how good our tyres and engineers are.

Q What specific challenges are there at the 'Ring?
The circuit is technically challenging and the surface changes considerably over the lap. Our European engineers have analysed the surface texture and composition over the lap length using a range of methods. This data has been sent to the race engineers in Japan to help us optimise the tyres we use for this track. We need a tyre that is super consistent. The drivers are in for longer stints and need predictability and [tyres that are] user friendly. The fact that we run for 24 hours means we need softer compounds for the night time running. We also need good inters and wets because the weather is so changeable.

Seishi Ikeki, race engineer, Falken Tyres

Seishi Ikeki has been involved in motorsport tyres since 1988, when he was a rally tyre engineer, and has been with Falken / Dunlop since 2003. Since 2005 he's been the race tyre engineer for Falken. Ikeki has been involved with the company's activities at the Nürburgring since 2001 – where it runs its own team at the 24 Hours – and has designed the tyres for the racecars since 2006.

RACE MOVES

Former Ferrari technical director, **Aldo Costa**, who relinquished his position with the race team in May, has now left the company altogether. Costa was originally planning to take an alternative position within Ferrari, but has now decided to leave. He will be on gardening leave until the end of the year.

Red Bull Racing technical director, **Adrian Newey**, has been presented with the MIA award for the Most Outstanding Personal Contribution to the Motorsport Industry. Newey joins an impressive list of previous MIA award winners, which includes **Harvey Postlethwaite, Ross Brawn** and **Frank Williams**.

Luis Perez Sala, who drove for Minardi in F1 in 1988 and 1989, has been appointed as an advisor to Thesan Capital, the Spanish investment company that has recently acquired the HRT Formula 1 team.

Luis Perez Sala

LAT

Sean Downes has taken on the role of managing director, business development, at NASCAR. He is based in the New York office and will report to **Jim O'Connell**, the Stock Car governing body's chief sales officer. From 2005 until 2009 Downes was NASCAR director of partnership marketing and was once vice president of corporate hospitality at Madison Square Garden.

James Allison, the technical director at Renault, has been named as the new head of the Formula One Teams' Association's Technical Regulations Working Group. He takes the place of former Ferrari technical director, **Aldo Costa**, who no longer works in Formula 1.

James Allison

LAT

George Lendrum has been appointed managing director of RML Group Ltd. Lendrum has had a 20-year career in the motorsport industry and was instrumental in the rapid growth of Cambridge-based Pi Research. He has also served on the Motorsport Industry Association Committee for the last 10 years.

Lisa Brown has left her position as CEO at Richard Petty Motorsports to become adviser to **Andrew Murstein**, president

RACECAR ENGINEERING COMPETITION

Win these 4 VELOCE books worth **£100!**

Here at Racecar Engineering we've teamed up with Veloce Publishing to offer one lucky reader four of the most exciting technical books in the industry.

1½-litre Grand Prix Racing 1961-65
- Low Power, High Tech
by Mark Whitelock

BRM V16
- How Britain's auto makers built a Grand Prix car to beat the world
by Karl Ludvigen

Alpine & Renault
- The Development of the Revolutionary Turbo F1 Car: 1968 to 1979
by Roy Smith

Tales from the Toolbox
- A collection of behind the scenes tales from Grand Prix mechanics
by Michael Oliver

ENTER ONLINE AT
www.racecarengineering.com/veloce2

RACE MOVES

of Medallion Financial Corp, and also a partner in ownership of RPM. Brown played a part in the re-structuring of the RPM NASCAR Sprint Cup programme over the winter months.

Brian Pattie is no longer Juan Pablo Montoya's crew chief at NASCAR Sprint Cup outfit, Earnhardt


LAT

Brian Pattie

Ganassi Racing. Pattie, who has crew chiefed for the Colombian since 2008, has been replaced by **Jim Pohlman**, who joined the Ganassi organisation in 2006 and has most recently been working with the engineering group in research and development.

Harry McMullen has taken on the role of general manager of NASCAR Sprint Cup outfit, TRG Motorsports. McMullen has previously worked for Roush Fenway Racing for some 30 years, including a stint as the team's general manager.

Former Formula 3 guru, **Bruce Jenkins**, has joined the Australian V8 Supercars outfit Mother Energy Racing Team, replacing **Andy McElrea** as team manager. Jenkins has previously worked in F3 with Hitech and Stewart, as well as F1 with Stewart and McLaren. McElrea has switched to his own Porsche Carrera Cup team.

Greg Erwin, recently replaced as crew chief for **Greg Biffle** at NASCAR team Roush Fenway Racing (see above), has moved on to Richard Petty Motorsports where he will crew chief for **AJ Allmendinger**. Erwin takes over from **Mike Shiplett** as the crew chief on the iconic no 43 RPM Ford.

Australian V8 Supercars ace, **Mark Skaife**, is to take up the role of chairman of the category's all-new V8 SC Commission in October. Joining Skaife on the


LAT

Mark Skaife

Commission will be three representatives of the teams: **Tim Edwards** (who will act as chairman), **Brad Jones** and **Ross Stone**, along with the series CEO, **Martin Whitaker**, and also **Chris Lambden**. The Commission will help oversee the expansion of the championship and the introduction of its Car of the Future, but its main role is to focus on rules, regs and formats.

Seishi Ikeki INTERVIEW

CONTINUED

Shoulder design, and the ability to push as much water out of the tread when it is wet, is an example of the attention to detail we consider for the N24 tyres.

Q Do you do anything special to avoid punctures on such a long track?

Yes, we have some features to avoid punctures. We also run TPMS [tyre pressure monitoring system] to give the drivers the opportunity to know as soon as there is a problem. And the way the drivers drive the car is different. With the [Porsche] 997 we have this year, as opposed to last year, they turn in much deeper to the apex, so we need to take care with the kerbs.

Q How many tyres are needed for a 24-hour race?

We bring four containers of tyres for our four drivers. This quantity obviously has a contingency for the different weather conditions we are likely to encounter, as well as the different compounds we need to maximise performance throughout the 24 hours. Nürburgring is so unpredictable. We've been going for over 10 years and have experienced everything from high temperatures through to freezing cold, but that's part of the attraction for our engineers.

Q How different is the Porsche tyre compared to the Nissan Z tyres from last year?

During tyre testing, to fix the compounds Peter Dumbreck [driver] told the engineers he found that oversteer is neutralised with the traction control. He also says the ABS is hugely impressive. This, together with the higher speeds - the Porsche is around 40 seconds quicker over a single lap - means there are greater loads. The Porsche is also heavier and the balance is different with it being rear-engined. So, while we retain the 18in diameter, we have had to do a lot of development to get the most from the 997.

Q Is your race tyre testing done on track or by simulation?

We check the many new ideas by simulation, or by using our test machine equipment. And then, of course, we test on track, if the results from the simulation suggest the ideas are worth developing.

Q Is the N24 tyre a different tyre to that used in GT2?

Yes, for sure. There are technical differences demanded by the rules, but also by the type of racing we have, and the duty cycle of the tyre. We'd rather keep some of these secret.

Q Would you go to Le Mans, or maybe the WRC, in the future?

At the moment there are no plans to participate in either Le Mans or in World Rally. We prefer at present to concentrate our activities on the [Nürburgring] 24 Hours and realise our objectives to achieve a strong result.

Q Why are Falken race tyres not for sale?

At present we don't have the capacity to produce the volume of race tyres to support more than our own team.

Q What challenges are there in race tyre design?

The drivers demand a lot of performance from the tyre. But many kinds of performance have a trade off. For example: grip and durability, response and traction. And the conditions always change - temperature, surface, weather etc. So we have to find a good balancing point of performance. On the other hand, we are trying to improve all performance. We always try new items to improve the ability, but the exact materials are, for sure, confidential.

Falken Tyres concentrates its motorsport activities at the Nürburgring 24 Hours

Get **Racecar Engineering** direct to your computer

THE WORLD'S LEADING MOTORSPORT TECHNOLOGY PUBLICATION

Each month **Racecar Engineering** brings the best possible insight into all forms of the rapidly changing world of motorsport engineering.

From keeping pace with the latest technologies to expanding your knowledge of racecar design and operation, no other magazine gets you closer.

Go to **www.racecar-engineering.com/digital** to get a sneak preview and see the latest great offers

RACE MOVES

Dennis Bickmeier is the new president of Richmond International Raceway, replacing **Doug Fritz**, who has resigned to pursue other career opportunities. Bickmeier formerly worked as vice president of consumer sales and marketing at Michigan International Speedway, and started his career at track owner International Speedway Corporation back in 1999.

Matt Puccia has been made crew chief for the **Greg Biffle**-driven car in Roush Fenway Racing's NASCAR Sprint Cup operation, taking over from **Greg Erwin**. Puccia has been with Roush Fenway Racing since the end of 2004, most recently as part of the organisation's research and development programme. He has also previously worked as a crew chief in NASCAR Trucks and Nationwide.

Matt Puccia

LAT

A crewman for the Red Bull Racing NASCAR Sprint Cup team has been fired for posting an anti-gay tweet. **Jeremy Fuller**, a tyre changer on the team, said that the post was meant as a joke.

Torrey Galida has taken on the newly created position of chief operating officer at NASCAR outfit, Richard Childress Racing. Galida comes to RCR from TRG Motorsports, where he served as the chief marketing officer and general manager for the NASCAR and Rolex Sports Car Series. He will be responsible for running RCR's day-to-day business activities and will report directly to RCR president and CEO, **Richard Childress**.

In other key management moves at RCR (see above), long-time executive at the team, **Ben Schlosser**, has been named chief marketing officer, while **Scott Frye** has been promoted to chief financial officer. Frye replaces **Art McArter**, who is to retire later this year.

Respected motorsport journalist, **Bill Boddy** MBE, has died at the age of 98. Boddy wrote for *Motor Sport* for some 81 years and was still contributing to the publication at the time of his death.

Moving to a great new job in motorsport and want the world to know about it? Or has your motorsport company recently taken on an exciting new prospect? Then send an email with all the relevant information to Mike Breslin at bresmedia@hotmail.com

GEORG PLASA OBITUARY

It is cruelly ironic that the publication in July's *Racecar Engineering* of the story on the amazing BMW 134 Judd created by European hillclimbing legend, Georg Plasa, should almost coincide with his untimely death on Sunday 10 July, in an accident at the Rieti hillclimb in Italy.

Plasa was an immensely popular competitor with a Europe-wide fan base who possessed a rare combination of special qualities: he was a first-rate engineer, and undoubtedly it was partly because he created extraordinary cars that he had such a following, but he was also an extremely talented driver.

Perhaps above all, though, his popularity came about because he was a very decent, kind and friendly human being. *Racecar Engineering* extends its condolences to his family, friends and team colleagues who, like the whole of the European Hillclimb fraternity, will be feeling an immeasurable loss.

Simon McBeath

Georg Plasa 1960-2011

WATCH THIS

http://www.youtube.com/watch?v=uC1v6fr7x8Y&feature=youtu.be

We could think of no better tribute to Georg Plasa than film of his amazing creation in action. Pay your respects on www.racecar-engineering.com

ROY WINKELMANN OBITUARY

Well known race team owner, Roy Winkelmann, has died at the age of 81. Winkelmann, who was a successful Sportscar driver in his native United States during the '60s, ran one of the best Formula 2 teams in Europe that decade and is credited with launching the international career of 1970 World Champion, Jochen Rindt.

After closing his team at the end of the 1960s, Winkelmann returned to the sport, working for Dan Gurney with the All-American Racers Eagle outfit, on the commercial side of the operation, chiefly in Formula 5000 and IndyCars.

Winkelmann was also behind a plan to run the Lotus 96T in IndyCar in the 1980s but sadly, after a change in the regulations, the car never started a race.

Roy Winkelmann 1930-2011

Former World Champion, Jochen Rindt, in a Winkelmann Racing Formula 2 car

Racecar engineering

PIT CREW

Editor Andrew Cotton
Deputy Editor Sam Collins
News Editor Mike Breslin
Design Dave Oswald
Chief Sub Editor Mike Pye
Staff Writer Lawrence Butcher
Contributing Editors Paul Van Valkenburgh
Technical Consultant Peter Wright
Contributors Charles Armstrong-Wilson, George Bolt jr, Gemma Hatton, Simon McBeath, Danny Nowlan, Mark Ortiz
Photography LAT, Gavin D Ireland
Group Sales Director Steve Ross
Tel +44 (0) 20 7349 3161
Email steve.ross@chelseamagazines.com
Head of Business Development Tony Tobias
Tel +44 (0) 20 7349 3176
Email tony.tobias@chelseamagazines.com
Senior Ad Sales Executive Lauren Mills
Tel +44 (0) 20 7349 3186
Email lauren.mills@chelseamagazines.com
Publisher Luke Bilton
Senior Publisher Sarah Arthur
Managing Director Paul Dobson
Editorial Racecar Engineering, Chelsea Magazine Company, Suite 19 Chelsea Wharf, 15 Lots Road, London SW10 0QJ UK
Tel +44 (0) 20 7349 1920
Advertising Racecar Engineering, Chelsea Magazine Company, 26-30 Old Church Street, Chelsea, London SW3 5BY UK
Tel +44 (0) 20 7349 3150
Fax +44 (0) 20 7349 3160
Worldwide Subscriptions CDS, Tower House, Sovereign Park, Market Harborough, Leics LE16 9EF UK
Tel +44 (0)1858 438749
Fax: +44 (0) 1858 434958
Subscription Rates
UK £72 (12 issues)
USA $135 (12 issues)
ROW £84 (12 issues)
News Distribution COMAG, Tavistock Road, West Drayton, Middx UB7 7QE
Printed by Wyndeham Heron
Printed in England
ISSN No 0961-1096
USPS No 007-969

recycle

www.racecar-engineering.com

BUMP STOP

Exit logic, stage left

The World Touring Car Championship has been going strong for six years but, in 2011, it faces its toughest challenge yet, with a single manufacturer, Chevrolet, dominating the results. Sure, in the past Alfa Romeo, BMW and SEAT have dominated various eras, but usually they have battled against each other.

This year, with the majority of factory teams gone and competition coming from privately-funded teams, a scan through the results does not make for good reading. Unless you are a Chevrolet fan. The RML-prepared Chevrolet Cruze has won 13 of the first 14 races, and set new records as Rob Huff and Yvan Muller won twice in a single weekend (at Monza and Donington respectively).

On paper, it looks as though Chevrolet has taken a sledgehammer to crack a nut but, in truth, Ray Mallock's team started work on its version of the Global Race Engine (GRE) months before anyone else, and have consequently stolen the march by some margin. Other manufacturers have now moved to the 2.0-litre, four-cylinder engine formula, but their delay was entirely unnecessary.

> "what should have been a sensible, logical step has backfired"

Like everything logical in racing, things got complicated. The WTCC had a fantastic formula – Super 2000 – which united race series around the world. The World Championship had the newest cars, the factory teams and the star drivers, while the national series had a steady supply of customer cars. The Intercontinental Rally Challenge also ran to Super 2000 regulations, and so the technology could be shared in different disciplines. It was simple, brilliant, and it worked.

When the Global Race Engine concept was announced, it made even more sense. A manufacturer could produce an engine that would serve as a basis for any number of racing programmes, including the WRC and, if the concept was adopted as planned, Formula 3, IndyCar and even Formula 1.

Sadly, the GRE didn't work as planned, and only the WRC and WTCC share the engine architecture. Other Touring Car series decided to follow their own route on engines, and the common harmony evaporated.

The WTCC was facing its own problems anyway. BMW left as a factory team to concentrate on endurance racing and then DTM, SEAT ceased its manufacturer involvement, Honda never committed, and the other Japanese manufacturers, targeted by organiser Marcello Lotti with a race in Okayama, never materialised.

What should have been a sensible, logical step has backfired. The WTCC now needs to convince manufacturers to build cars to its regulations and, judging by the paddock visitors in Donington, it seems to be on the right track.

Volvo is going through the homologation process with the C30 and will run a full factory team next year. Ford's Jost Capito, the director of global performance vehicles and motorsport business development, was an interested observer at Donington mid-July, and many expect the manufacturer to commit for 2013.

Lotti has followed the same formula to attract Ford as he did with the Japanese, and pencilled in a race at Sears Point, or the Infineon Raceway as it is officially called these days, next September. It is the right track for the WTCC cars anyway, and it will be interesting to see who else responds to this open invitation.

BMW and SEAT continue to support their customer teams, but are both reaching a point where they need to make decisions. In September, BMW will decide whether or not to homologate the new 3-series for sale to its private teams, but with a DTM programme sucking up time, money and effort, it remains to be seen whether it has the capacity to do so. The SEAT Leon is also getting long in the tooth, though in Gabriele Tarquini's hands it is the only car to have broken Chevrolet's dominance this season. Whether the appetite or the finance is there to produce a new car has yet to be seen. For now, though, the series is concentrating on Volvo for 2012 and Ford in 2013, and hoping logic will prevail for others.

EDITOR
Andrew Cotton


Made for winners!
inox-line
OSRAM
40
www.vln.de
KEIPER
WEISS
1
KW
Coilovers
Coilovers in 3 dampening variants
Max. technical lowering
With german TÜV-certificate
KW
Clubsport
Optimum performance on the race track
With adjustable top mounts
For the race track and the road
KW
Competition
Motorsport suspension for top-level motorsport
2- and 3-way adjustable
Numerous motorsport successes
Made in Germany
KW
Coilovers
KW automotive GmbH
Phone: +49 7971 9630-0
www.KWsuspensions.de
KW automotive Noth America, Inc.
Phone: +1 888 721 3888
www.KWsuspensions.com
KW automotive UK Ltd
Phone: +44 870 990 7536
www.KWautomotive.co.uk


WHAT'S IT FEEL LIKE ON THE
OTHER SIDE OF THE FENCE?
FIND OUT.
www.performancefriction.com
NEW!
Visit our
facebook shop!
PERFORMANCE
FRICTION
BRAKES